B.Tech (PIE) 5th Semester

CODE	COURSE	L	T	P	Credits
PIPC301	Production Technology – III	3	0	0	3
PIPC302	Production Planning & Control	3	0	0	3
PIPC303	Machine Design**	2	0	4	4
PIPE***	Any one subject from Group III	3	0	0	3
PIPE***	Any one subject from Group IV	3	0	0	3
OE*		3	0	0	3
PIIC314	Internship/Training/Project Viva-Voce (4-6 weeks duration after 4th semester examination)				2
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				21

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

*****Not to be counted towards integrated course.***

PROGRAM ELECTIVES

GROUP - III		GROUP - IV	
CODE	COURSE	CODE	COURSE
PIPE304	Refrigeration and Air Conditioning	PIPE309	Computer Aided Design
PIPE305	Design of Heat Exchangers	PIPE310	Industrial Automation and Robotics
PIPE306	Renewable Energy Systems	PIPE311	Industrial Tribology
PIPE307	IC Engines and Gas Turbine	PIPE312	Mechatronics
PIPE308	Computational fluid dynamics	PIPE313	Vibrations and Noise

MECHANICAL ENGINEERING DEPARTMENT
PIPC301: PRODUCTION TECHNOLOGY-III

Pre-requisite: Production Technology-II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

This course provides students with an understanding of various processes of production technology and skills relating to the implementation of these technologies in the modern industry. Topics include basics of powder metallurgy, theory of welding, gear manufacturing and broaching, foundry processes, etc.

UNIT-I

Powder Metallurgy: Introduction, Theory of powder metallurgy, manufacture of metal powders, sintering, secondary operations, properties of finished parts, design considerations and industrial applications. **(06 hrs)**

UNIT-II

Gear Manufacturing and Broaching: Classification of gear production methods, gear forming, gear generation: gear hobbing, gear shaping, production of helical, spur, and bevel gears, gear finishing methods: shaving, burnishing, grinding, lapping, honing, Broaching: Broach, cutting action of broach, broaching operations, broaching machines, mechanics of broaching and problems on machining time calculation. **(10 hrs)**

UNIT-III

Composite Materials and their Processing: Introduction, Types of Composites materials, Agglomerated Materials, Reinforced materials, Laminates, Surface Coated Materials, Production of Composite Structures, Fabrication of particulate composite Structures, Fabrication of reinforced Composite, Fabrication of Laminates, Machining, Cutting and Joining of Composites. **(08 hrs)**

UNIT-IV

Foundry and casting: Sand testing, Solidification of Alloys and its mechanism – Gating system design and estimation of solidification time – Riser Design and Riser placement – Defects and Product Design. Cooling curves, nucleation and dendrite formation, gating system: Pouring time, choke area, Gating ratios, in-gate design, Riser Design: Caine's method, Modulus method, chills, grouping castings, feeding aids. **(16 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

TEXT/REFERENCE BOOKS

1. Sharma P C, "Production Engineering", S Chand & Company,1997.
2. Heine, R.W., Loper, C.R. and Rosenhal, P.C., "Principles of Metal Casting", TMH.
3. P.N. Rao, "Manufacturing Technology", TMH
4. Pandey and Singh, "Production Engineering Sciences"
5. Ghosh & Mallik, Manufacturing Science, Affiliated East West Press.
6. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials and Processes in Manufacturing", Prentice-Hall of India.
7. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
8. Groover, M.P., "Fundamentals of Modern Manufacturing", JohnWiley & Sons.
9. Mix, Paul E, "Introduction to Nondestructive Testing: A Training Guide", John Wiley and Sons Ltd, 1999.
10. Henrique L M, "Non Destructive Testing and Evaluation for Manufacturing and Construction", Hemisphere Publishers, New York, 2001.
11. Kuo, S., "Welding Metallurgy", John Wiley & Sons 2003
12. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill 1988.

Course Outcomes

CO1: Explain the applications of powder metallurgy in manufacturing sector.

CO2: Classify the various gear manufacturing processes along with their finishing processes.

CO3: Fabricate the composite materials and their effective processing.

CO4: Test the weld quality and design the various elements of casting.

MECHANICAL ENGINEERING DEPARTMENT
PIPC302: PRODUCTION PLANNING AND COTROL

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course imparts knowledge about the various planning and control techniques in a manufacturing or production plant.

UNIT - I

Introduction to PPC and Manufacturing systems: Introduction: Manufacturing function; Elements of production systems; objectives and the ten functions of production planning and control, concept of production and productivity. Types of production systems, Job, Batch and Mass production system, Product, Process and Cellular layouts, Line Balancing using LOT rule. Product Development & Design: Effect of competition on design, Long-range Planning, Company policy, product analysis, marketing aspects, the product characteristics, functional aspect, operational aspect, durability and dependability, Aesthetic aspect; Economic analysis, Profit and competitiveness, The Three S Concept- Standardization, Simplification and Specialization, Break Even Analysis. **(14 hrs)**

UNIT – II

Forecasting: Concepts and applications, demand forecasting, principle of forecasting, forecasting techniques, quantitative and qualitative methods of forecasting, Trend adjusted exponential smoothening, assessment of forecasting error, signals.

Aggregate Production Planning and Scheduling: Concept, strategies for aggregate planning: three pure planning strategies, master production scheduling (MPS), and procedure for developing MPS. Scheduling of jobs, Gantt Chart, FCFS rule, Johnson's rule, Problems on sequencing. **(10 hrs)**

UNIT – III

Inventory Control: Definition, classification, objectives of inventory control, functions, costs of inventory, economic order quantity, Economic Batch size, Deterministic demand models, POQ model, Safety stock and probabilistic demand models, V.E.D. analysis, S-D-E analysis, F-S-N analysis, H-M-L analysis and ABC analysis

Process Capability and Control Charts: Introduction to process capability, Indexes Cp and CpK, Computation of sigma level, Number of defects vs. Sigma Level, Introduction to control charts, Causes of variation, Control charts for variables and attributes, X Chart, P Chart, R Chart, C Chart. **(12 hrs)**

UNIT – IV

Case studies with application: Case studies based on application of various tools and techniques.

(4 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Buffa, E.S., and Sarin, R.K., "Modern Production / Operations Management", John Wiley & Sons,1994
2. Mukhopadhyaya, S.K., "Production Planning and Control – Text and Cases", PrenticeHall of India,2004
3. Adam, Jr., E.E., and Ebert, R.J., "Production and Operations Management: Concept, Models and Behavior", 5th Ed., Prentice-Hall of India, 2001
4. Vollman, T.E., Berry, W.L., and Why bark, D.C., "Manufacturing Planning and Control Systems" 4th Ed., McGraw-Hill, 1997
5. Sipper, D., and Buffin, R.L., "Production: Planning, Control and Integration", McGrawHill, 1997.

Course Outcomes

CO 1: Students will be able to understand the fundamentals of Production Planning and Control.

CO 2: Understand the major concept of product development and design.

CO 3: Students will learn about the forecasting and aggregate planning techniques.

CO4: Develop an understanding of various Inventory Control Concepts, Inventory models, Inventory Costs and ABC Analysis.

MECHANICAL ENGINEERING DEPARTMENT
PIPC303: MACHINE DESIGN

Pre-Requisites: Material Science, Strength of Materials, ToM

L	T	P	Credits	Total contact hours
2	6	0	4	40

Brief Description about the course

This course will introduce the students to the design procedures involved in various machine elements. The learning objectives of this course are:

- To understand the behavior of a machine component subjected to different loads and recognizing the failure criterion.
- To identify the stresses induced in a machine component and design it to avoid failure using theories of failure.
- Apply design methods for mechanical components such as gears, springs to meet the required criteria, along with strength requirements.
- Apply engineering principles to open ended design problems
-

UNIT-I

Basics Concepts & Design for Strength: Design methodology, Design criterion based on fracture, deformation and elastic stability, design stress, factor of safety Selection of Engineering Materials, Theories of Failure

Stress concentration, causes and mitigation, Endurance limit, Notch sensitivity, Factors affecting endurance limit, Design for finite and infinite life. Soderberg and Goodman diagram.

(10 hrs)

UNIT-II

Design of Joints & Springs: Riveted joints for boiler shell according to I.B.R., riveted structural joint and riveted joint with eccentric loading. Types of welded joints, strength of welds under axial load, welds under eccentric loading. Designation of various types of bolts and nuts. Design of bolted joints, bolts of uniform strength. Bolted joints with eccentric load.

Introduction, Helical springs: stress analysis, deflection analysis, spring materials, styles of ends. Design against static and fluctuating loads: Design of leaf springs. **(10 hrs)**

UNIT-III

Design of Shaft, Keys, Couplings & Gears: Design of shafts subjected to pure torsion, pure bending load. Combined bending and torsion, combined torsion, bending and axial loads. Design of keys, Types of shaft couplings. Design of sleeve or muff coupling, flange coupling and bush

type flexible couplings.
Introduction: spur gear, helical gear. Calculation of load carrying capacity, design of spur and helical gears for dynamic and wear loads, bearings reactions. **(10 hrs)**

UNIT-IV

Design of Bearing: Introduction, Classification of bearings, selection of bearings, sliding contact bearings. types, materials, lubricants, properties of lubricants, hydrodynamic lubrication and design of hydrodynamic journal bearing: Rolling contact bearings: types, selection of rolling contact bearings and comparison of rolling and sliding contact bearing.

Case studies: Concepts of Manual, Automated Manual, Automatic and Dual Clutch transmission systems of automobiles and their working principles be studied **(10 hrs)**

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Text Books/ References

1. Shigley, J.E., and Mischke, C.R., Mechanical Engineering Design, McGrawHill International Editions, New York, Edition VI, 2003
2. V B Bhandari, Design of Machine Elements, 2nd Ed., Tata Mcgraw Hill, 2007.
3. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher Kalaikathir Achchagam, Coimbataore, 2009.
4. M.F Spotts, T.E Shoup, L.E. Hornberger, S.R Jayram, and C. V. Venkatesh, Design of Machine Elements, 8th Ed., Person Education, 2006
5. Paul H Black and O. E. Adams, P., Machine Design, 3/e, Mc Graw Hill Book Company, Inc., New York, USA., 2007.
6. R. C Juvinall and K. M Marshek, Fundamentals of Machine Component Design, 3rd Ed., Wiley Student Edition, 2007.
7. Robert L. Norton, Machine Design – An Integrated Approach, Prentice-Hall Inc.
8. V B Bhandari, Machine Design Data Book

C**ourse Outcomes**

CO1:Apply and implement design concepts

CO2:Design a machine component to meet strength requirements

CO3:Identify the failure modes and design the components like gears, springs etc.

MECHANICAL ENGINEERING DEPARTMENT
PIPE304: REFRIGERATION AND AIR CONDITIONING

Pre-requisite: **Thermodynamics**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This Course provides a simple understanding of Refrigeration and Air-conditioning fundamentals. Ideally suited to those with a little or no knowledge of the subject. The course consists of different refrigeration cycles and understanding of psychrometry and psychrometric processes used for the purpose of air-conditioning. Further, the comfort air-conditioning and indoor environment health are also addressed in this course.

UNIT-I

Introduction: A Refrigerating Machine - The Second Law Interpretation, Heat Engine, Heat Pump and Refrigerating Machine, units of refrigeration, Energy Ratios or Coefficients of Performance, Heat Pump vs. Electric Resistance Heater, Best Refrigeration Cycle: The Carnot Principle, Reversed Carnot Cycle, Effect of Operating Temperatures, Selection of Operating Temperatures, Problem Solving, Vapour as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle.

Air Refrigeration: Limitations of Carnot Cycle with Gas as a Refrigerant, Reversed Brayton or Joule or Bell Coleman Cycle, Analysis of Gas Cycle, Application to Aircraft Refrigeration, Simple Aircraft Refrigeration Cycle with Ram Compression, Problem Solving, Dry Air Rated Temperature, Air-cycle Systems for Aircraft Refrigeration: Simple System & Bootstrap system, Problem Solving, The Joule–Thomson Coefficient and Inversion Curve.

(8 hrs)

UNIT-II

Vapour Compression System: Work in Reciprocating Compressor, Modifications in Reversed Carnot Cycle with Vapour as a Refrigerant, Dry Versus Wet Compression, Throttling Versus Isentropic Expansion,

Vapour Compression Cycle, P-h Charts, Vapour Compression System Calculations, Ewing's Construction, Standard Rating Cycle and Effect of Operating Conditions, Depiction of actual refrigeration cycle on T S & P-h.

Multi-Pressure Systems: Introduction, Multistage or Compound Compression, Flash Gas Removal, Flash Intercooling, Choice of Intermediate Pressure, Complete Multistage Compression System, Problem Solving, Multi-Evaporator Systems, Cascade Systems, Solid Carbon Dioxide - Dry Ice.

Refrigerants, Nomenclature/designation of refrigerants, selections, Thermodynamic requirements, chemical requirements, physical requirements, Environmental impact of refrigerants,

Vapour Absorption Systems: Faraday's Experiment, Simple vapour Absorption refrigeration system, comparison between absorption and vapour compression systems, Ammonia water system, lithium bromide, Problem Solving, Thermodynamic requirements of Mixtures Refrigerant – Absorbent pair characteristics: Electro-Lux refrigerator, Problem Solving.

(14 hrs)

UNIT-III

Properties of Moist Air: Psychrometric Properties of moist air, Specific Humidity or Humidity Ratio, Dew Point Temperature, Problem Solving, Degree of Saturation, Relative Humidity,, Enthalpy of Moist Air, Humid Specific Heat, Problem Solving, Wet Bulb Temperature, Thermodynamic Wet Bulb Temperature or Temperature of Adiabatic Saturation, Psychrometric Chart, Application of First Law of thermodynamics to a Psychrometric Process, Problem Solving,

Psychrometry of Air-Conditioning Processes: Mixing Process, Problem Solving, Basic Processes in Conditioning of Air: Sensible heating, Sensible cooling, Humidifying, Dehumidifying, Heating, and humidifying, Cooling, and dehumidifying, Cooling, and humidifying, Heating, and dehumidifying, Psychrometric Processes in Air-Conditioning Equipment, Bypass Factor, Heating Coils, Air Washer, Adiabatic Dehumidifier, Water Injection, Steam Injection, Problem Solving, Summer Air Conditioning, Winter Air Conditioning.

(12hrs)

UNIT-IV

Design Conditions: Choice of Inside Outside Design Conditions, Outside Design Conditions, Cold storage, Industrial air conditioning. Comfort Air Conditioning and Effective Temperature, Comfort, The Metabolic Rate, Mechanism of Body Heat Loss, Mathematical Model of Heat Exchange between Man and Environment, Purposes of Ventilation, Air Filters

Load Calculations and Applied Psychometric: Preliminary Considerations, Internal Heat Gains, System Heat Gains, Break-up of ventilation load and effective sensible heat factor, Cooling load estimate, Heating Load Estimate, Psychometric calculations for cooling, Selections of air conditioning apparatus for cooling and dehumidification, Evaporative cooling, building requirement and energy conservation in air conditioning buildings.

(6 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. CP Arora, Refrigeration & Air-conditioning, TMG.
2. NPTEL Video Course Refrigeration and air-conditioning, Dr. Ravi Kumar is a Professor in the Department of Mechanical & Industrial Engineering, Indian Institute of Technology Roorkee.

3. Manohar Prasad, Refrigeration & Air-conditioning, NAI.
4. Stoecker & Jons, Refrigeration & Air-conditioning, MGH.
5. RC Dosset, Principles of Refrigeration, LPE.
6. ASHRAE Handbook (Fundamentals), ASHRAE.

Course Outcomes

CO1: At the end of the course students should be able to understand the need and importance of various refrigeration and air conditioning cycles, the typical and some advanced and innovative schematic designs, and the goals of R&AC systems.

CO2: Students should be able to design the VCRS and VARS with improving performance parameters.

CO3: Students should be able to describe the working of different types of air conditioning systems.

CO4: Student should be able to understand the actual applications of RAC.

MECHANICAL ENGINEERING DEPARTMENT
PIPE305: DESIGN OF HEAT EXCHANGERS

Pre-requisite: Heat Transfer, Fluid Mechanics and Machines

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course
NA

UNIT- I

Classification and basic design methodologies for heat exchanger: Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, effectiveness-NTU method for heat exchanger analysis, fouling, cleanliness factor, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology. Design of double pipe heat exchangers: Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop, design calculation of double pipe heat exchanger, double pipe exchangers in series-parallel arrangements

(14 hrs)

UNIT- II

Shell and tube heat exchangers: Tube layouts, baffle spacing, classification of shell and tube exchangers, design calculation of shell and tube heat exchangers, shell-side film coefficients, shell-side equivalent diameter, true temperature difference in a 1 shell 2 pass exchanger, influence of approach temperature on correction factor, shell and tube sides pressure drop; performance analysis of 1 shell 2 pass heat exchangers, flow arrangements for increased heat recovery. Design of Shell and Tube Heat Exchangers incorporating sustainable development and related technologies. **(10 hrs)**

UNIT- III

Direct contact type heat exchangers: Classification of cooling towers, wet-bulb and dew point temperatures, Lewis number, cooling-tower internals, heat balance, heat transfer by simultaneous diffusion and convection; Design and analysis of cooling towers, determination of the number of diffusion units, performance evaluation of cooling towers, influence of process conditions and operating variables on their design. Design of cooling towers incorporating sustainable development and related technologies. **(10 hrs)**

UNIT- IV

Heat Transfer Enhancement Techniques and Compact Heat Exchangers: Heat transfer enhancement, heat transfer and pressure drop in plate fin heat exchanger and tube fin heat exchanger, Performance evaluation of Compact Heat Exchangers. Design of CHEs incorporating sustainable development and related technologies. **(6 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Incropera, Dewitt, Bergmann and Levine, "Fundamentals of Heat and Mass Transfer", Wiley India, 2006.
2. D.S. Kumar, "Heat and Mass Transfer", Katson Publication, 2013.
3. Kern, D. Q., Process Heat Transfer, Tata McGraw-Hill, 2000.
4. Fraas, A. P., Heat Exchanger Design, Second Edition, John Wiley & Sons, 1989
5. N.H. Afgan and Schliinder, "Heat Exchangers Design and Theory", McGraw Hill.

Course Outcomes

CO1: The students will be able to design heat exchangers employing all the three modes of heat transfer.

CO2: The students will be able to identify different types of heat exchangers and use them for appropriate applications.

MECHANICAL ENGINEERING DEPARTMENT
PIPE306: RENEWABLE ENERGY SYSTEMS

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

NA

UNIT- I

Energy Science & Technology: Forms of Energy, Nuclear energy, Hydro energy, Renewable energy, Energy demand, Energy statistics, Comparison of fuels such as wood, charcoal, coal, kerosene, Diesel, petrol, furnace oil, LPG, biogas and electricity on calorific value and cost basis, Efficiencies of various Energy production methods. Ministry of Power, Ministry of New and Renewable Energy, Energy Auditing and Management, Energy Conservation Act, Bureau of Energy Efficiency, Schemes and policies of PCRA. **(08 hrs)**

UNIT- II

Solar Energy: Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications. Solar Collectors, Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Flat-plate collectors: types; Thermal analysis; Thermal drying. Selective surfaces - Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization. **(10 hrs)**

UNIT- III

Bio-energy: Energy Generation from wastes: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digester – factors affecting bio-digestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in municipality and medical.

(12 hrs)

UNIT- IV

Wind Energy: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. – Site Selection Criteria – Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data – Organizations like C-WET etc., Wind Energy Conversion System - Design - Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Twidell & Weir, Taylor and Francis, "Renewable Energy Sources", 2nd Special Indian Edition.
2. G.D. Rai, Dhanpat Ral and Sons "Non-conventional Energy Sources".
3. Tiwari and Ghosal, Narosa, "Renewable Energy Resources".

Course Outcomes

CO1: Understanding of commercial energy and renewable energy sources.

CO2: Knowledge in working principle of various energy systems.

CO3: Capability to do basic design of renewable energy systems.

CO4: Upon completion of this course, the students will be able to identify the new methodologies / technologies for effective utilization of renewable energy sources.

MECHANICAL ENGINEERING DEPARTMENT
PIPE308: COMPUTATIONAL FLUID DYNAMICS

Pre-requisite: Fluid Mechanics & Machines

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

NA.

UNIT- I

Introduction: Introduction to C.F.D., models of flow, governing differential equations – continuity equation, momentum equation, energy equation, Navier- Stokes equation, physical boundary conditions.

Mathematical behaviour of governing equation: Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations. **(10 hrs)**

UNIT- II

Discretization methods: Finite difference methods, difference equations, explicit & implicit approach, errors & analysis of stability. Basics of finite control volume method.

Heat conduction problem: Solution of One dimensional heat conduction through a fin, solution of two dimensional steady state and transient heat conduction problems, heat conduction problems in cylindrical coordinates: axisymmetric and non-axisymmetric problems. **(12 hrs)**

UNIT- III

Heat conduction with convection & diffusion: Steady state one dimensional convection and diffusion, upwinding, exact solution, exponential scheme, hybrid scheme, power law scheme, Discretization equation for two dimensions & three dimensions, false diffusion. **(08 hrs)**

UNIT- IV

Other Hydraulic Pumps: Viscous incompressible flow, solution of the couette flow problem by F.D.M., calculation of the flow field using stream function – vorticity method, numerical

algorithms for solving complete Navier-Stokes equation – MAC method; SIMPLE method.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Suhas. V. Patankar, Numerical heat transfer and fluid flow, Hemisphere.
2. John. D. Anderson, Jr, Computational fluid dynamics, McGraw Hill.
3. Vesrteeg and Malalsekera, An Introduction to Computational fluid dynamics- The Finite Volume Method, Longman Scientific and Technical.
4. Anil .W. Date, Introduction to Computational fluid dynamics, Cambridge University Press.
5. Niyogi, Chakraborty and Laha, Introduction to Computational fluid dynamics, Pearson Education.

Course Outcomes

CO1: Understand the concepts of PDEs and apply them to CFD problems.

CO2: Understand discretization and its application to problems.

CO3: Solve problems related to heat transfer and fluid flow using Finite Difference and Finite Volume Methods.

CO4: To understand the limitations and errors involved in solution to CFD problems.

MECHANICAL ENGINEERING DEPARTMENT
PIPE309: COMPUTER AIDED DESIGN

Pre-requisite: Machine Drawing

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will introduce the students to the geometric modelling and engineering analysis techniques required to model and analyze objects for application in CAD, CAM, Computer Graphics and many other engineering applications. To this end, the learning objectives of this course are:

- To understand 2D & 3D geometric transformation techniques and apply the same to obtain orthographic, perspective, axonometric and oblique projections
- To develop mathematical models to represent curves and surfaces
- To understand and generate solid geometries

UNIT – I

Introduction to design process and role of computer in design, Historical developments, Industrial look at CAD/CAM, Basics of geometric and solid modeling, explicit, implicit, intrinsic, extrinsic and parametric equations coordinate systems

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, 3D rotation about an arbitrary axis, 3D reflection through an arbitrary plane, orthographic, Axonometric, Oblique and perspective projections**.** **(10 hrs)**

UNIT – II

Curves: Algebraic and geometric forms, Analytical & Synthetic Curves, tangents and normal, blending functions, re-parametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves; Rational curves, Non-uniform Rational curves,

Surfaces: Algebraic and geometric forms, Analytical and Synthetic Surfaces, tangents and twist vectors, normal, blending functions, sixteen-point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surfaces, Coons surface, Triangular patches. **(10 hrs)**

UNIT-III

Solids: Solid models and representation scheme, Fundamentals of Solid Modeling, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, Half spaces**.** **(10 hrs)**

UNIT-IV

Case Studies: Develop computer codes for Wireframe modelling and 3D transformations of simple solids such as cuboid, pyramid, wedge etc; Geometric modelling and mesh generation for an involute profile spur gear; Stress analysis of a simply supported beam subjected to uniformly distributed load. **(10 hrs)**

NOTE:

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Text Books / Reference

9. CAD/CAM by Groover and Zimmer, Prentice Hall
10. CAD/CAM: Theory and Practice by I. Zeid, Tata McGraw Hill
11. Mathematical Elements for Computer Graphics by Rogers & Adams, McGraw Hill.
12. Computer Aided Engineering Design by Anupam Saxena and Birendra Sahay, Springer
13. An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill
14. The Finite Element Method in Engineering by S.S. Rao, Pergamon Press
15. Textbook of Finite Element Analysis by P. Seshu, PHI Learning

Course Outcomes

CO 1: Geometrically transform 2D & 3D entities (such as, lines, surfaces and solids)
CO 2: Generate curves and surfaces by developing mathematical models
CO 3: Model components using solid modeling techniques

MECHANICAL ENGINEERING DEPARTMENT
PIPE310: INDUSTRIAL AUTOMATION AND ROBOTICS

Pre-requisite: ToM

L	T	P	Credits	Total contact hours
03	00	0	3	40

COURSE DESCRIPTION:

This course is designed for B.Tech students to impart the knowledge about i) Fundamentals of Industrial automation, Levels of automation and different Automation Methodologies, ii) Types of Hydraulic and Pneumatic systems in industrial automation, iii) Understanding of Programmable Logic Controllers and Distributed Control System used in industrial robots, iv) Understanding of Industrial robots, types of robotic joints and motions, actuators, Robots kinematics and dynamics, Robot vision and the programming. Following will be course learning objectives

1. To understand the automation need, type, and methodologies.
2. To understand the hydraulic and pneumatic systems of automation.
3. To understand Programmable Logic Controllers (PLC) and its circuits, Distributed Control System (DCS), its integration with PLC and advantages.
4. To understand the concept of robotics, robotic programming, and robot vision.

UNIT- I

Introduction to Automation: Fundamentals of automation, necessity, and architecture of automated systems. Principles and architectures for automation in industry. Levels of automation, automation safety, maintenance, error detection, and repair diagnostics.

Automation Methodologies: Elements of automated systems, types of systems such as hydraulic, pneumatic, and hybrid systems. Assembly-line automation - Conveyor, part feeders, material transport systems, and automated assembly.

(10 hrs)

UNIT- II

Hydraulic Systems in Automation: Hydraulics: Fluid properties, Pascal's Law and applications, Fluid power symbols, Hydraulic pumps, Sizing of Pumps, Pump Performance, Characteristics and Selection, Control valves: Direction control valves, Pressure control valves, Flow control valves, Hydraulic Proportional Valves, Servo valves. Accumulator- types, application circuits. Design and analysis of typical Industrial hydraulic circuits. Accessories used in fluid power systems, Filtration systems, and maintenance of systems.

Pneumatic Systems in Automation: Pneumatics: Gas laws, Preparation of air, Fluid conditioning elements, Actuators, Sizing of Actuators, Control valves: Direction control valves, Pressure control valves, Flow control valves. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling, Pneumatic circuit design:

Cascade method, step–counter method. Fluid logic devices. Circuits using Fluid logic devices and applications. **(10 hrs)**

UNIT - III

Programmable Logic Controllers: Basic Structure, Input / Output Processing, Programming with Timers, Internal relays and counters, Shift Registers, Master and Jump Controls. Data Handling, Analogs Input / Output. Electrical controls for Fluid power circuits.

Distributed Control System**:** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS**.** **(10 hrs)**

UNIT - IV

Introduction of Robotics: Definition of a robot, types of robotic joints and motions, classifications of robots based on: Physical configurations, actuators, and motion control; Terminologies used for robotics specification and selection for industrial applications; Types of end effectors.

Robot Kinematics and Dynamics: Homogeneous coordinates and co-ordinate transformations, kinematic parameters, use of Denavit-Hartenberg representation for finding arm equation of robotic arms, forward and inverse kinematics for basic industrial robotic configurations, SCARA configurations, Basics of Robot Dynamics.

Robot Vision and Programming: Sensing and digitization of vision data, image processing: image data reduction, segmentation, feature extraction, object recognition, and training of vision system, Robot programming methods, Robot Programming Languages

Case study1: To design and develop a small scale robotic manipulator for various industrial applications like pick and place robots etc.

Case study 2: To develop the programme for robotic arm used for welding applications like TIG welding, MIG welding, SPOT welding etc.

Case study 3: To develop the programme for robotic arm used for material handling applications.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Antony Espossito, “Fluid power with Applications ", Pearson, Sixth Edition., 2003.
2. W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” – PrenticeHall - 2013 - 5th Edition
3. Singh, Shio Kumar. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010.

4. Sullivan James A., “Fluid Power - Theory and Applications”, Fourth Edition, Prentice Hall International, New Jersey, 1998.
5. Petruzella, Frank D. Programmable logic controllers. Tata McGraw-Hill Education, 2005.
6. Watton, John. Fundamentals of fluid power control. Vol. 10. Cambridge University Press, 2009.
7. Mikell Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2019.
8. Jon Stenerson, Industrial Automation and Process Control, Pearson, 2003.
9. Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Education, 2013. 3. Industrial Robotics: Technology, Programming and Applications by M.P. Grover and N. G. Odrey, TMH Edu. India
10. Robotics: Control and Programming by J. Srinivas, Rao V. Dukkipati and K. Ramji, Alpha Science International.

Course Outcomes:

CO1: Understand the automation need, type, and methodologies.

CO2: Understand the hydraullic and pnematic systems of automation.

CO3: Understand Programmable Logic Controllers (PLC) and its circuits, Distributed Control System (DCS), its integration with PLC and advantages.

CO4: Understand the concept of robotics, robotic programming, and robot vision.

MECHANICAL ENGINEERING DEPARTMENT
PIPE311: INDUSTRIAL TRIBOLOGY

Pre-requisite: None

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

The course will introduce the students to various types of tribological phenomena, the concept of friction, modes of wear, and lubrication which is required to design and develop the engineering surfaces in contact. This course educates students about concepts of tribology, surface engineering, and theories of friction. With this course student will learn the various modes of lubrication, types of wear, and wear-resistant materials.

UNIT-1

Introduction and Concept of Friction: Introduction to tribology, different scales of tribology; micro/nano, bio and green tribology, engineering surfaces, structural and topographical states of surface, contact of engineering surfaces, concept of surface engineering and its significance, concept, and classification of friction, laws of friction, theories of dry friction, stick-slip motion, and friction, instabilities, friction & vibration interaction, measurement of friction.

(10 hrs)

UNIT-II

Lubrication and Wear: Introduction, lubricant viscosity, application of lubricants, basic modes of lubrication, properties of lubricants, types of lubricants, lubricant additives, mechanism of pressure generation in lubricant. Introduction to wear, causes of surface degradation, different modes and mechanisms of wear, types of wear testing, wear resistance materials, corrosion, and tribo-corrosion phenomenon. **(10 hrs)**

UNIT-III

Surface Engineering Techniques: Surface hardening methods, diffusion coatings, hot dip coatings, galvanized coating, weld over-lay methods, introduction to thermal spraying and its applications, suspension spraying, cold spraying, warm spraying, vapor deposition methods, friction surfacing, laser, electron-beam, and microwave processing **(10 hrs)**

UNIT-IV

Bearings and Bearing Materials: Geometry and pressure equation of journal bearing, hydrostatic bearings, thrust bearings, porous bearings and hydrodynamic gas bearings, journal bearings with specialized applications, general requirements, and different types of bearing materials.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Principles and Applications of Tribology, by B. Bhushan, John Wiley & Sons.
2. Engineering Tribology, by G. Stachowiak and A.W. Batchelor, Tribology series 24, Elsevier, Amsterdam.
3. Fluid Film Lubrication, By B. Hamrock, NASA Reference Publication.
4. Microstructure and wear of materials, by K.H. Zumgahr, Tribology series, Elsevier, Amsterdam.
5. Coatings tribology: properties, mechanisms, techniques and applications in surface engineering, by K. Holmberg & A. Matthews, Tribology and interface engineering series, Ed. 2nd, Elsevier, Oxford.

Course outcomes

CO1: Knowledge of different scales of tribology, surface topography, and emerging concepts.

CO2: Knowledge of the friction, wear, and lubrication mechanisms and will be able to apply them to practical engineering problems.

CO3: Knowledge to reduce friction and wear for engineering surfaces.

CO4: Knowledge of design and develop new engineered surfaces for the better life of mechanical components.

MECHANICAL ENGINEERING DEPARTMENT

PIPE312: MECHATRONICS

Pre-requisite: None

L	T	P	Credits	Total contact hours
3	-	-	3	40

Brief Description about the Course

Mechatronics is a multidisciplinary field that refers to the skill sets in the advanced automated manufacturing industry. A mechatronics engineer unites the principles of mechanics, electrical, electronics and computing to generate economical and reliable systems. Mechatronics integrates sensors, actuators, power electronics, microprocessors and decision & control. Mechatronics engineering is the design of computer-controlled electromechanical systems. Mechatronics is used in manufacturing, healthcare, robotics, space exploration and in tools that make our lives easier.

UNIT-I

Introduction to Mechatronics and its Systems: Evolution, Scope, Measurement Systems, Subsystems and integration of mechanical & electrical systems using computer based control, Control Systems, open and close loop systems, Practical applications of mechatronics, mechatronics approach.

Basics of Digital Technology: Electronic Components & Devices, Number System, Logic gates, Boolean algebra, Logic Functions, Applications. **(10 hrs)**

UNIT-II

Sensors and transducers: Introduction, performance terminology-Displacement, Position and Proximity, Velocity and motion, force, Fluid Pressure-Temperature Sensors-Light Sensors-Selection of Sensors-Signal Processing.

Pneumatic and Hydraulic actuation systems: Actuation systems, Pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, process control valves, rotary actuators. **(10 hrs)**

UNIT-III

Mechanical actuation systems: Mechanical systems, types of motion, kinematics chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection.

Microprocessor: Introduction, Architecture, Pin Configuration, Instruction set, Programming of Microprocessors using 8085 instructions-Interfacing input and output devices-Interfacing D/A converters and A/D converters, Applications, Temperature control, Stepper motor control.

(10 hrs)

UNIT-IV

Programmable Logic Controller: Introduction, Basic structure, Input/output Processing, Programming, Mnemonics, Timers, Internal relays and counters, Data handling, Analog Input/Output, Selection of a PLC.

Robotics: Introduction, types of robots, Robotic control, Robot drive systems, Robot end effectors, selection parameters of a robot, applications. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. Bolton W., "Mechatronics", Longman, Second Edition, 2004.
2. Histand Michael B. and Alciatore David G., "Introduction to Mechatronics and Measurement Systems", McGraw Hill International Editions, 2003.
3. Kamm, M.L.J., Mechatronics, Prentice Hall of India, New Delhi (2007).
4. HMT Ltd., "Mechatronics", Tata McGraw Hill Publishing Co. Ltd., 1998.
5. A Text Book of Mechatronics, R K Rajput.
6. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", Tata McGraw-Hill publishing company Ltd, 2003.
7. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall, New Jersy (1996).

Course outcomes:

CO1 Understand the basic concepts of mechatronics, digital technology and their applications.

CO2 Understand the functioning of various types of sensors, transducers and their applications.

CO3 Understand the concept of pneumatic, hydraulic and mechanical actuation systems.

CO4 Perceive the functioning of microprocessors, Programmable logic controllers, their architecture, structure and applications.

MECHANICAL ENGINEERING DEPARTMENT
PIPE313: VIBRATION AND NOISE

Pre-requisite: ToM

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description

Vibration and noise occurs in the mechanical components which are in motion and most of the time undesirable for the smooth functioning of that components. The study of a dedicated course is required to understand the fundamental and advance concepts of vibrations and Noise for engineers and designers. Following are the course learning objectives:

1. To understand the periodic disturbances caused by external excitation, rotational and reciprocating imbalance, support excitation affects a machine's performance.
2. To acquire the knowledge for vibration analysis of physical bodies and Noise analysis.
3. To learn Mathematical Modelling of Mechanical Systems for vibration and Noise analysis.
4. To learn methods of Vibration isolation, Noise reduction of Mechanical systems under periodic inputs.

UNIT- I

Fundamental of Vibrations: Introduction to mechanical vibration, Definitions, Classifications of Vibration, Kinematics of simple vibrating motions, Fourier series representation of periodic Inputs, Vibration Analysis Procedure, Mathematical Model for Vibration Analysis.

Free Vibrations of a Single Degree of Freedom Systems: Degrees of freedom, equations of motions, general solution of equation of motions, Rayleigh's Energy Method, Undamped and Damped free vibrations of Mechanical Systems. Logarithmic Decrement, Stability of Systems

(**10 hrs**)

UNIT- II

Forced Vibrations of a Single Degree of Freedom Systems: Forced vibrations of the damped and undamped systems, Transient and Steady state response, Various type of damping, Forced vibration – due to external excitation; due to rotating and reciprocating unbalance; due to excitation of the support, Transmissibility and isolation, Self-Excitation and Stability Analysis, Vibration measuring Instruments. (**10 hrs**)

UNIT-III

Multi-Degrees of Freedom Systems: Modeling of Continuous Systems as Multi-degree of-Freedom Systems, Using Newton s Second Law to Derive Equations of Motion, Influence Coefficients, Undamped Forced Vibration, Generalized Coordinates, Coordinate Coupling, Principal Coordinate, Eigenvalue Problem, Modal Analysis.

Determination of Natural Frequencies of Multi-Degrees of Freedom Systems: Numerical Methods: Dunkerley's Method, Rayleigh's method, Method of Matrix iteration, Holzer's method, Rayleigh–Ritz method. (**10 hrs**)

UNIT - IV

Noise Control in Mechanical System: review of Fundamentals, Noise and vibration measurement units, levels, decibels, spectra. Objective/Subjective noise measurement-scales; Addition and subtraction of decibles; Frequency analysis bandwidths; Relationships for the measurement of free field sound propagation; The directional characteristics of sound sources; Sound power models. Industrial Noise and Vibration Control: Basic sources of industrial noise and vibration, basic industrial noise and vibration control methods; The economic factor; Sound transmission from one room to another acoustic enclosures, acoustic barriers, sound absorbing materials; Vibration control procedures; Fault detection from noise and vibration signals.

(**10 hrs**)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Mechanical vibration by S. S. Rao, Pearson Education
2. Mechanical Vibration by Thomson, Prentice Hall
3. Mechanical Vibration by Den Hartog, McGraw-Hill
4. Introductory course on Mechanical Vibrations by Rao and Gupta, Wiley Eastern
5. Mechanical vibration by G.K. Grover, Nem chand & Brothers
6. Norton, M.P., and Karcazub, D.G., "Fundamentals of Noise and Vibration Analysis for Engineers", 2nd 2003 Ed., Cambridge University Press

Course Outcomes:

CO1: Perform vibration and noise analysis of the Mechanical systems using mathematical modelling

CO2: Solve governing equation of motions of the Mechanical systems using Numerical Methods as well as exact analysis.

CO3: deal with mechanical systems involving vibration isolation and rotating and reciprocating unbalance.

CO4: Apply the Noise reduction methods on the physical systems.

B.Tech (PIE) 6th Semester

CODE	COURSE	L	T	P	Credits
PIPC315	Quality Control and Assurance	3	0	0	3
PIPC316	Work Study and Ergonomics	3	0	0	3
PIPC317	Experimental Design	3	0	0	3
PIPE***	Any one subject from Group V	3	0	0	3
PIPE***	Any one subject from Group VI	3	0	0	3
OE*		3	0	0	3
PIPC328	Work Study and Ergonomics (P)	0	0	2	1
PIPC329	Technical Discussions	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				24

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

PROGRAM ELECTIVES

GROUP - V		GROUP - VI	
CODE	COURSE	CODE	COURSE
PIPE318	Computer Integrated Manufacturing	PIPE323	Automobile Engineering
PIPE319	Sustainable Manufacturing	PIPE324	Finite Element Method
PIPE320	Materials Management	PIPE325	Thermal Power Engineering
PIPE321	Numerical Methods in Manufacturing	PIPE326	Solar Energy
PIPE322	Rapid Prototyping	PIPE327	Power Plant Engineering

MECHANICAL ENGINEERING DEPARTMENT
PIPC315: QUALITY CONTROL AND ASSURANCE

Pre-requisite: PPC

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

This course will present the theory and methods of quality and reliability monitoring including control charts, process capability, acceptance sampling and reliability based quality models etc. to give the participants necessary tools for the development of efficient statistical methods for assuring high quality in manufacturing sector.

UNIT - I

Introduction: definitions of quality, quality dimensions and aspects; concept of quality control and quality assurance, quality Gurus philosophies, basic quality control tools- old and new, Six Sigma, just-in-time, quality circle, variability concept in manufacturing cycle, fishbone diagram, charts in time philosophy.

(10 hrs)

UNIT-II

Statistical Process Control: control charts and application, Type-1 and Type II errors, effect of control limits on errors, effect of sample size on control limits, sample size, Type of control charts- control chart for variable and attribute, different adaptations of control charts, manufacturing process variability, Process capability- process capability study using control charts and capability evaluation- C_p, C_{pk} and P_p, P_{pk}.

(10 hrs)

UNIT-II

Acceptance Sampling: Operating Characteristic Curve (O-C curve); Effect of sample size and acceptance number, Single, Double and Multiple Sampling Plans, Acceptance/ rejection and acceptance/ rectification plans. Producer's risk and consumer's risk. Indifference quality level, Average Outgoing Quality (AOQ) curve, AOQL. Quality protection offered by a sampling plan. Average Sample Number (ASN) curve, Average Total Inspection (ATI) curve, design of single sampling plans.

(10 hrs)

UNIT-IV

Reliability: Concepts of reliability in quality, product quality based Bath tub curve, Mean Time to Failure, reliability in series and parallel configuration of a product, effect of redundancy in reliability, method of reliability evaluation, availability and maintainability concepts.

sustainable practices in quality assurance, case studies for improving product and service quality, total quality management, ISO 9000, application of RCA and FMEA for sustainable product operation.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Grant E L and Leavenworth R S, "Statistical Quality Control", McGraw Hill, Sixth Edition (2000)
2. Amitava Mitra, "Fundamentals of Quality Control and Improvement", Pearson Education Asia, Third Edition (2014)
3. Douglas C. Montgomery "Introduction to Statistical Quality Control", John Wiley & Sons, Inc., New York, 7th Edition (2013)
4. Srinath L S "Reliability Engineering", Affiliated East-West Press Limited, New Delhi, 2002.

Course Outcomes

CO1: Students will learn the fundamentals of quality management.

CO2: Students will be able to understand the basic statistical concepts based control charts.

CO3: Students will be able to understand acceptance sampling and sampling Plans based concepts and applications.

CO4: Students will understand the reliability and its relationship with quality.

MECHANICAL ENGINEERING DEPARTMENT
PIPC316: WORK STUDY AND ERGONOMICS

Pre-requisite: PPC

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course
Work study and ergonomics is a subject in Production and Industrial Engineering that focuses on applying the concepts of techniques like method study and work measurement to understand human work potential in terms of time spend for completing a task, looking at ways to make the task simpler and easy so as to increase productivity and efficiency. Work study is used for finding ways of increasing job performance, optimizing usage of plant and machinery and standardization of work methods. Ergonomics is complementary to work study and aids in designing or arranging workplaces, products and systems so that they best fit the people who use them.

UNIT- I

Productivity and Work-Study: Productivity: Concept and definition, Difference between production and productivity, Reasons for low productivity, factors influencing productivity, productivity measures, productivity measurement models, methods/techniques to improve productivity, Work content, Numerical Problems.

Work-Study: Definition, Historical development of work study, objective and scope of work study. Human factor in work study, Work study and management, work study and supervisor, work study and worker, qualities of work-study man **(8 hrs)**

UNIT- II

Method-Study: Definition, objectives, step-by-step procedure, selection of job for method study, questioning techniques, charts and diagrams for recording data: outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, models and templates, cycle graph, Chrono-cycle graph, Therbligs, Micro motion study and film analysis, Memo-motion study, SIMO chart, Principles of motion economy, development and installation of new methods. Numerical problems and Case studies. **(10 hrs)**

UNIT- III

Work–Measurement: Introduction & definition, various techniques of work-measurement, objectives and basic procedure of work measurement; application of work measurement in industries; time study: basic procedure, equipment needed, methods of measuring time, selection of jobs, breaking a job into elements; numbers of cycles to be timed; rating and methods of rating, allowances, work sampling, normal time, standard time, numerical problems, Predetermined Motion Time System and its types, Work Factor System, Method Time Measurement and Basic

Motion Time, MOST, calculation of standard time, Numerical problems and case studies.

(10 hrs)

UNIT- IV

Ergonomics: Introduction, history of development, objectives, applications of ergonomics, related sciences of ergonomics, man-machine system and its components, design of Man Machine Systems, characteristics of man machine system, man versus machines, Aspects of man machine system: design of information/visual displays, design of controls, Design of work posture, environmental factors and working conditions: effect of vibration, noise, temperature and illumination on performance. Applied Anthropometry - types, use, principles and applications, design of work place and seat design, Significance of Ergonomics in industry 4.0, Case study: Ergonomic design consideration for designing office chair.

Design of lifting tasks using NIOSH lifting equation, Distal upper extremities risk factors, risk assessment tools; Strain Index, RULA, REBA. **(12 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference Books

1. Barnes Ralph M., Motion & Time study: Design and Measurement of Work, Wiley Text Books, ed. 7th, 2001.
2. Marvin E, Mundel & David L, Motion & Time Study: Improving Productivity, Pearson Education, 2000.
3. Benjamin E Niebel and Freivalds Andris, Methods Standards & Work Design, McGraw Hill, 2013.
4. International Labour organization, Work-study, Oxford and IBH publishing company Pvt. Ltd., New Delhi, 2001.
5. Sanders Mark S and McCormick Ernert J, Human Factors in Engineering and Design, McGraw-Hill Inc., 1993.
6. Sharma S K and Sharma Savita, "Work Study and Ergonomics", S K Kataria & Sons., Delhi, 2014.
7. Dr. P.C. Tewari, "Work Study and Ergonomics",CRC Press U.K.. 2018
8. Lakhwinder Pal Singh, "Work Study and Ergonomics", Cambridge University Press. 2016
9. R.S.Bridger -Introduction to Ergonomics, Taylor and Francis, 2003

Course Outcomes

CO1: Understand the productivity and Work Study concepts and their applications

CO2: Demonstrate the tools and techniques of method study

CO3: Determine standard time of a job using the various techniques of work measurement

CO4: Understand the prime concepts of Ergonomics and its significance in relation to the design of work place and controls etc.

MECHANICAL ENGINEERING DEPARTMENT
PIPC317: EXPERIMENTAL DESIGN

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Experimental Design Techniques cover a wide range of tools, methods and techniques of statistics for investigation and enhancement /optimization of product design, Process performance, Process Quality. This course is targeted on providing insight into the different aspects of DOE like introduction to basic statistical concepts and tools, choice of experimental design, methodology for optimization of responses of interest, drawing inferences from the statistical analysis etc. The students will learn to apply the concepts of DOE for experimental research on the given problem.

UNIT-I

Objectives for experimental design, Basic design concepts: Randomization, Blocking and Replication, Steps in designing the experiments, Types of experimental designs, Sampling distributions.

Statistical Inference: Generation of hypotheses, Testing of hypotheses, OC curve, Tests on means, Tests on variances, Assessing normality, Model adequacy tests, Orthogonal Contrasts, ANOVA rationale, Confidence limits on means, Components of variance. **(8 hrs)**

UNIT-II

Completely Randomized Design: Model for a completely randomized design with a single factor, ANOVA for a completely randomized design, Randomized block design, Incomplete block design, Latin square design, One way ANOVA, Two way ANOVA, Balanced ANOVA.

Full Factorial Design: Nature of factorial designs, Estimation of Interaction effects, Main effect estimates, The 2^3 design, Built-in-replication, 3^3 design, Confounding systems, ANOVA for full factorial design.

(12 hrs)

Unit III

Robust Designs: DOE and Taguchi approach. Experimental Design using orthogonal arrays, Experimental design with two and three level factors, ANOVA for Taguchi method, Signal-to-Noise Ratio, Case study on application of robust design.

(10 hrs)

Unit IV

Response Surface Methodology: Introduction to response surface, building empirical models, First order and second order models, Approximating the response function, Estimation of the parameters in linear regression models, hypothesis testing and ANOVA for multiple regression, Testing Lack of fit, Fitting second order model to data, Two level factorial designs, addition of center points, two level fractional factorial designs. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Design and Analysis of Experiments by D.C. Montegomery, John Wiley and Sons, 2003/04, ISBN-978-81-265-1048-1
2. Design of Experiments using the Taguchi Approach by Ranjit K Roy, John Wiley, NY, 2006.
3. Fundamental Concepts in Design of Experiments, Charles R. Hicks, Oxford University Press, NY, 1999.
4. Response Surface Methodology: Product and Process Optimization using Designed Experiments, Raymond H. Myers, D.C. Montegomery, Wiley, 2009.

Course Outcomes

CO 1: Understand the fundamentals of experimental design.
CO 2: Identify the DOE technique to be applied for the given experimental problem
CO 3: Apply the DOE techniques to optimize the product/process parameters.
CO4: Evaluate the model adequacy; interpret the findings of the DOE study and to draw the appropriate inferences at the selected level of confidence

MECHANICAL ENGINEERING DEPARMENT
PIPE318: COMPUTER INTEGRATED MANUFACTURING

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:
This course introduces the importance, concepts and components of computer integrated manufacturing.

UNIT-I
Introduction to manufacturing enterprise, External and internal changes, World-class winning criteria, Introduction to CIM concepts, Three step process for CIM implementation.
Manufacturing Systems: Manufacturing classifications, Product development cycle, Enterprise organization. **(10 hrs)**

UNIT-II
Design Automation: Computer-Aided Design and Engineering: Introduction, General system operation, CAD classification: Hardware and software platforms, Application of CAD to manufacturing systems, Design for manufacturing and assembly, Computer-aided engineering analysis and evaluation.
Manufacturing Planning and Control: Introduction, planning the manufacturing planning and control system, master production schedule, inventory management, product data management. **(10 hrs)**

UNIT-III
Material Planning, Production Scheduling and Operating Systems: Material requirement planning, Capacity requirement planning, MRP II, Just-in-time manufacturing.
Enterprise Resoruce Planning: MRP II-a driver of effective ERP systems, information technology, the decision to implement ERP system, Features of modern manufacturing planning and control systems. **(10 hrs)**

UNIT-IV .
Production Support Machines and Systems: Industrial robots, automated material handling systems, automated guided vehicles, automated storage and retrieval systems.
Machine and System Control: System overview, Cell control, Proprietary versus Open system interconnect software, Device control, programmable logic controllers, Computer numerical control, Automatic tracking, Network communications. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Computer-integrated manufacturing, James A. Rehg and Henry W. Kraebber, Pearson Education.
2. Computer Integrated Manufacturing Technology and Systems, U. Rembolt, C. Blume, R. Dillmann, Dekker,
3. Computer Integrated Design and Manufacturing, D.D. Bedworth, M.R. Henderson, P.M. Wolfe, McGraw Hill.
4. Systems Approach to Computer Integrated Design and Manufacturing, N. Singh, John Wiley & Sons.
5. Automation Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson

Course outcomes:

CO1: To understand CIM and its scope

CO2: To understand product design and manufacturing in CIM environment

CO3: To understand manufacturing planning and control in CIM environment

CO4: To understand hardware and software requirements for CIM as well as implementation of CIM

MECHANICAL ENGINEERING DEPARTMENT
PIPE319: SUSTAINABLE MANUFACTURING

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

Sustainable manufacturing is the creation of products through economical processes that minimize negative environmental impacts with conservation of energy and resources. Sustainable manufacturing also enhances employee, community and product safety. Understanding concepts and their practical applications is essential for production engineering students, as Industry 4.0 will continue to transform manufacturing processes. As production engineering students, understanding of Industry 4.0 is crucial because it is revolutionizing the manufacturing landscape and shaping the future of industrial production.

UNIT - I

Sustainable manufacturing: concept of triple bottom line, environmental, economic and social dimensions of sustainability, relation between lean and sustainable manufacturing, tools and techniques, environmental quality function deployment, life cycle assessment, design for environment, R3 and R6 cycles, design for disassembly, design for recycling.

(10 hrs)

UNIT - II

Environmental impact assessment methods: CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, environmental impact parameters. sustainability assessment-concept models and various approaches, product sustainability and risk/benefit assessment, corporate social responsibility, sustainable characteristics of manufacturing processes, energy efficiency analysis of manufacturing processes, software packages for sustainability analysis and LCA, scope of sustainable manufacturing research centers.

(10 hrs)

UNIT III

Various industrial revolutions, overview on technologies of Industry 4.0, comparison of Industry 4.0 factory and today's factory, challenges and opportunities for Industry 4.0., pillars of Industry 4.0.

(10 hrs)

UNIT-IV

Industry 4.0 Enablers, supportive technologies of industry 4.0, Industry 4.0 framework, emerging trends in sustainable manufacturing and Industry 4.0, case studies of Industry 4.0 enabled factories in different countries.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Jean-Claude Andre, "Industry 4.0 – Paradoxes and Conflicts", 2019, ISBN: 9781786304827, Wiley-ISTE.
2. 1. G. Atkinson, S. Dietz, E. Neumayer, "Handbook of Sustainable Manufacturing". Edward Elgar Publishing Limited, 2007.
3. 2. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, UN New York, 2007.
4. 3. Rainer Stark and Günther Seliger, "Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives (Sustainable Production, Life Cycle Engineering and Management)", Springer, 2017
5. 4. J. Paulo Davim, "Sustainable Manufacturing", Wiley-ISTE, 2013
6. Klaus Schwab, "The Fourth Industrial Revolution", 2017, ISBN: 9781524758868, Currency Publisher, Illustrated edition.
7. John F Killman, "Nanotechnology And Molecular Manufacturing: Techniques, Risks And Benefits", 1993, ISBN: 9788178884691, Dominant Publishers And Distributors.
8. P. Kaliraj, T. Devi, "Big Data Applications in Industry 4.0", 2022, ISBN 9781032008110, CRC Press, Taylor & Francis Group

Industry", 2022, ISBN 9781032008127, CRC Press, Taylor & Francis Group.

Course Outcomes:

CO 1: Students will understand and explore the opportunities of sustainable manufacturing environment.

CO 2: Students will analyze and differentiate the different pillars of Industry 4.0.

CO 3: Students will understand and apply the knowledge of Industry 4.0 enablers like additive manufacturing, robotics and automation for today's factory.

CO 4: Students will analyze and develop the implementation strategies of AI, and IIoT for the factories of future in Indian manufacturing context.

MECHANICAL ENGINEERING DEPARTMENT
PIPE320: MATERIALS MANAGEMENT

Pre-requisite: PPC

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Materials management covers to an extensive view of function, theoretical and conceptual concepts of materials management in any industral organizations. The organization is functioning by fundamentals information of procurement process and significant role of purchasing decisions. The proposed course is targeted on providing insight into the basics concept of inventory management approaches and sustainable deals with economical model of EOQ and EPQ selections in stores management practices. The study will also learn to the various inventory management practices in various organizations and overcomes the financial loss in inventory holding and operational costs. Also understand the concept of sustainable inventory management practices such as inventory planning, stores management, inventory approaches and production activities control for significant sustainable applications.

UNIT-I

Introduction, Material requirement plans and planning process. Bills of material, Capacity Management: Definition of capacity, capacity planning, Capacity requirement planning, capacity available and required, Scheduling order, make plan. Cost reduction and value improvement, value analysis for right choice and rationalization of materials productivity.

(8 hrs)

UNIT-II

Purchasing planning & Forecasting: Establishing specifications, selecting suppliers, price determination, demand management, demand forecasting, principle of forecasting, forecasting techniques, seasonality, tracking the forecast, inventory and flow of materials, supply and demand pattern, centralized versus decentralized purchasing, timing of purchases. Mode of Tender, Tender Enquiry, Tender Opening, Techno Commercial Evaluation, Tender Purchase Committee /Negotiation Committee Purchase Order / Contract, Post Contract Management, vender selection and vender rating. Purchase price analysis and price determination. Purchasing as a dynamic profession like e-procurement, e-procurement system and e-publishing. Overview of Government e-Marketing (GeM). **(12 hrs)**

UNIT-III

Physical inventory Management: Basic concepts of inventory, types of inventories, inventory turnover ratios, Functions and scopes of inventories, ABC, VMI, VED and FSN system of selective inventory, EOQ, EPQ, variation of EOQ models, sensitivity analysis of EOQ model,

period order quantity, quantity discount. Identifying critical or specific items with selective inventory management. Inventory management system 2.0.

Stores management: Introduction, Stores functions, types of stores layouts, stores organization, stores systems and procedures, Receipt & Inspection Note (RIN), Certified Receipt Voucher (CRV), stores accounting and verification systems, stores address systems, stores location and layout, store equipment. **(10 hrs)**

Production Activity and Control: Data requirements, order preparation, scheduling, load levelling, scheduling bottlenecks, production reporting

Logistic support in Just in time manufacturing environment: JIT philosophy, JIT environment, manufacturing planning and control in JIT environment, MRP, MRPII, Kanban, theory and constraints. Cross-Docking Distribution Centre, Logistic support system, National logistic system, sustainable inventory management.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference:

11. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials and Processes in Manufacturing", Prentice-Hall of India.
12. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
13. Groover, M.P., "Fundamentals of Modern Manufacturing", John Wiley & Sons.
14. Lindberg, R.A., "Processes and Materials of Manufacture", Prentice-Hall of India.
15. Boothroyed, G. et al., Fundamentals of Metal Cutting and Machine Tools, McGraw Hill.
16. Rao,P.N., "Manufacturing Technology", Vol 1 & 2, Tata McGraw-Hill.
17. Ghosh and Mallik, "Manufacturing Science", E.W. Press.
18. Pandey and Singh,"Production Engineering Science".
19. Avitzur, B., "Metal Forming: Processes and Analysis", Mc-Graw Hill.
20. Hazra & Choudhary Workshop Technology Vol. II Tata MCGraw Hill

Course Outcomes

CO1: To understand the leaning practices & concepts of materials management process.

CO2: To understand the basic fundamentals of purchasing function, e-procurement process.

CO3: To understand the basic concepts of inventory management approaches and economic order quantity.

CO4: Develop the basic concepts of cost-effective stores management, material handling & operational logistic support system and its applications.

MECHANICAL ENGINEERING DEPARTMENT
PIPE321: NUMERICAL METHOD IN MANUFACTURING

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course This course introduce numerical techniques used in analysis of numerous manufacturing processes. The purpose of this course is to provide basic understanding of the derivation and the use of the numerical methods along with the knowledge of finite precision arithmetic. The source codes for the following problems are to be developed by the students and results should be verified.

UNIT-I

Basics of Numerical Analysis: Significant figures, Accuracy and Precision, accuracy of numbers, computer representation of numbers. Error definitions, Round-off errors and truncation errors in numerical computation, error propagation, total numerical error.

(8 hrs)

UNIT-II

Roots of non-linear equations: bisection method, false-position method, secant method, iteration method, newton-raphson method.

Solution of linear equations: gauss elimination without and with partial pivoting, gauss-jordon, iterative methods: jacobi's iteration and gauss seidel method.

Eigen value and eigen vectors: eigen values & eigen vectors, properties of eigen values.

(12 hrs)

UNIT- III

Numerical Differentiation: Derivatives using Newton's Forward-differences, Backward-differences, Center-differences. Integration: Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rule.

(8 hrs)

UNIT-IV

Numerical Solution of Ordinary Differential Equations: Taylor series method, Euler's method, Modified Euler's method, 2^{nd} and 4^{th} order Runge-Kutta method, Predictor-corrector method and Milne's predictor-corrector method. **(12 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Jain, M. K., Iyengar, S. R. K. and R. K., "Numerical Method for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi, 2000.
2. Grewal, B. S., and Grewal, J. S., Numerical Method in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
3. Numerical Solution of Partial Differential Equations: Finite Difference Methods, by G. D. Smith, Oxford University Press, 1985.
4. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th edition Wesely, 2002.
5. Analysis of Numerical Methods, by E. Isaacson & H. B., Keller, John Wiley & Sons

Course Outcomes

CO1: Evaluate errors associated with computation methods.

CO2: Demonstrate practice of numerical techniques for accurate and efficient solution of models based on linear/nonlinear systems of equations, ordinary differential equations.

CO3: Formulate numerical models for various manufacturing processes.

CO4: Apply various numerical models and methods for drawing conclusions and making decisions under uncertainty in Production engineering contexts.

MECHANICAL ENGINEERING DEPARTMENT
PIPE322: RAPID PROTOTYPING

Pre-requisite: PT-III, MD

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course: Rapid Prototyping course will focus on different rapid prototyping techniques and tools to build product in less time. This course will have following learning objectives

1. To provide knowledge of Rapid Prototyping
2. To gain an insight of Rapid Prototyping technologies
3. To understand the knowledge of pre and post processing techniques during Rapid Prototyping
4. To acquire the knowledge of Rapid Tooling, use of Reverse Engineering for product development

UNIT I

Computer Aided Design and Computer aided Manufacturing (CAD-CAM) and its integration, Rapid Prototyping (RP), Product development and its relationship. Introduction to AM, AM/3D printing process chain: Conceptualization, CAD, STL file, Transfer to 3D printing, STL file manipulation, Repair of STL files, Machine setup, build, removal and clean up, post processing. Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, solid sheet system. Process chain for Rapid Prototyping, Reverse Engineering and CAD model, Digitizing Techniques: Contact and Non-contact based, Coordinate measuring machine (CMM), Computed Tomography (CT) and 3D scanning.

(12 Hrs)

UNIT II

Fused Filament Fabrication (FFF): Factors affecting part orientation, support structure design, Automatic support structure generation. Model Slicing and Contour Data organization: Model slicing and skin contour determination, Identification of external and internal contours, Contour data organization, Direct and adaptive slicing

(10 Hrs)

UNIT III

Parameters affecting part building time in Fused Filament Fabrication (FFF) and powder Bed fusion process printer, Recoating, part quality. Part removal, finishing, curing. Other issues: Shrinkage, Swelling, Curl and distortion, Surface Deviation and accuracy, different defects in built 3D printing component and remedies

(8 Hrs)

UNIT IV

Rapid Tooling and Manufacturing: Classification of Rapid Tooling Routes, Rapid Prototyping of Patterns, Direct Rapid Tooling: Direct Rapid Tooling method for Soft and Bridge Tooling, Indirect Rapid Tooling: Indirect method for Soft and Bridge Tooling, Future Directions of AM: Introduction, new types of products and employment. A Rapid prototyping case study based on experimental development of FFF components as a mini project.

(10 Hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific, 2010.
2. Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs.
3. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
5. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Course Outcomes

On completion of the course will be able

CO1: To comprehend various types of rapid prototyping techniques

CO2: To apply various designing and slicing techniques that enable 3D printing and create programming for tool path.

CO3: To comprehend the product development cycle, RT processes and reverse engineering solutions

CO4: To create RP components by applying fundamental knowledge of different process.

MECHANICAL ENGINEERING DEPARTMENT
PIPE323: AUTOMOBILE ENGINEERING

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course provides an introduction to vehicle structure, engine, automotive electric and electronic systems, automotive drive trains, steering system, brakes and suspension systems; it also provides an introduction to engine emissions and their control and offers various alternative fuels that can be used in automobiles.

UNIT- I

Introduction to Automobile Engineering: Importance, applications, job opportunities, classification, types of vehicles, basic structure, general layout, and hybrid vehicles.

Automotive Electric and Electronic SystemsElectric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles. **(10 hrs)**

UNIT- II

Automotive Drive Trains:

Clutches: Requirements and principle of clutches, dry friction clutches, clutch components, types of clutches-single plate, multi plate, semi centrifugal and centrifugal, clutch operation, wet clutch, clutch dynamics, Clutch trouble shooting.

Transmission: Necessity & functions of transmission, types of transmission, sliding mesh gear box, constant mesh gear box, synchromesh gear box, selector mechanism, transfer box, automatic transmission, epicyclic gear box, principle of automatic transmission, Driveline dynamics: Engine Dynamics, Driveline & Efficiency, Gearbox dynamics.

Propeller Shaft and Rear Box: Propeller shaft, universal joints, final drive, differential, rear axle, rear axle drives, rear axle casing, improvements in four wheel drive. **(10 hrs)**

UNIT- III

Steering, Brakes and Suspension Systems:

Wheels and Tyres; Steering system: Steering Geometry, camber, castor, king pin, rake, combined angle toe-in, toe-out, types of steering mechanism, Ackerman steering mechanism, Davis steering mechanism, steering gears types, steering linkages, Power Steering, Braking system: Mechanical brake system, Hydraulic brakes system, Master cylinder, wheel cylinder, Requirements of brake fluid, pneumatic and vacuum brake, Antilock Braking System (ABS); Suspension System: Need of Suspension System, Types of Suspension, Suspension Springs, Constructional Details and Characteristics of Leaf, Coil and Torsion Bar Springs, independent Suspension, Rubber Suspension, Pneumatic Suspension, Shock Absorber. **(10 hrs)**

UNIT- IV

Emissions from Automobiles: Emissions from automobiles, pollution standards national and international, pollution control techniques, petrol injection, common rail diesel injection, variable valve timing; Energy alternatives, solar, photovoltaic, hydrogen, biomass, alcohols, LPG, CNG, liquid fuels and gaseous fuels, hydrogen as a fuel for internal combustion engines, their merits and demerits. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Kirpal Singh, “Automobile Engineering Vol. I & II”, Standard Publishers, New Delhi, 2011.
2. Tom Denton, “Automobile Electrical and Electronics Systems”, Butterworth-Heinemann (2003).
3. William H Crouse & Anglin D L "Automotive Mechanics", Tata McGraw Hill Publishing Company, 2006
4. Joshep Heitner, “Automotive Mechanics”, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2004.
5. R.B. Gupta, “Automobile Engineering”, Satya Prakashan Publisher, New Delhi.

Course Outcomes

CO1: Understand the concept of various vehicle structure and identify the usage of electrical and hybrid vehicles.

CO2: Analyze the working principles and operations details of clutches and transmission systems.

CO3: Evaluate the operational details and design principles of steering, braking and suspension systems.

CO4: Compare the effects of emissions from automobiles. And to know the ways and means of reducing emissions.

MECHANICAL ENGINEERING DEPARTMENT
PIPE324: FINITE ELEMENT METHOD

Pre-requisite: Strength of Materials

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course is an introduction to solving different types problems existing in the area of fluid, solids, heat which are described with their respective governing differential equations. The course compares the performance of finite element with the previously well-established finite difference. The primary focus of the course is to expose the students to solving problems in these seemingly areas from the governing equation. The course provides a well-balanced approach, covering both the physical concepts and mathematical operations, supplemented with practical examples and exercises. By the end of the course, students will possess a strong foundation in finite elements, enabling them to effectively apply essential principles, laws, and relevant equations in the engineering design of machines for specific applications.

UNIT-I

Introduction to Finite Element Method with Integral Formulations and Variational Methods: Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods. Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach. **(7 hrs)**

UNIT-II

Finite Element Techniques: Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials. **(12 hrs)**

UNIT-III

Applications To Solid, heat and fluid mechanics problems and Structural Mechanics Problems: External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, Analysis of trusses, frames and solids of revolution, computer programs.Variational approach, **(10 hrs)**

UNIT-IV

Applications fluid mechanics problems: Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems. Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

(11 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. The Finite Element Method byZienkiewicz, Tata McGraw Hill

2. The Finite Element Method for Engineers by Huebner, John Wiley

3. An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill

4. The Finite Element Method in Engineering by S.S. Rao, Pergamon Press

Course Outcomes

CO1: At the end of the course student will be able to solve the problems existing in various areas of fluid, solids and great from the governing equation point of view.

CO2: They would program the various methods existing in this area and thus will be able to implement design concepts to practical problems.

CO3: Select the suitable type of material considering the type of working conditions they are to withstand.

MECHANICAL ENGINEERING DEPARTMENT
PIPE325: THERMAL POWER ENGINEERING

Pre-requisite: Thermodynamics, HT

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course

The course on Thermal Power Engineering course offers a straightforward comprehension of the subject matter. It covers various aspects, such as the basic steam power cycle, including reheat, regeneration, and superheating. Additionally, it delves into actual cycles with component efficiencies and provides detailed discussions on each component of the power plant. The course also includes comprehensive studies on gas and diesel thermal power plants. Furthermore, it addresses the economic and environmental aspects of power generation.

UNIT-I

Introduction: Introduction to thermal power, Description and classification of boilers, Boiler mountings & accessories, Natural draught, Artificial draught: Chimney design, Steam jet draught and mechanical draught, Calculation of boiler efficiency & equivalent evaporation. Vapour Power Cycles: Carnot cycle, Simple & modified Rankine cycles, Effect of operating variables on Rankine cycle, Rankine cycle with superheating, Reheating & regeneration, Reheat factor, Binary vapour cycle. **(10 hrs)**

UNIT-II

Steam Turbines: Introduction, Classification of steam turbines, Working principle, Compounding, Velocity diagrams, Calculation of power output and efficiency, Condition for maximum efficiency, Degree of reaction, Governing of steam turbine.

Steam (Thermal) Power Plants: Analysis of steam power cycles for power plant application; High pressure boilers- La-Mont boiler, Benson boiler, Loeffler boiler; Velox boiler; Super pressure steam power plants; Economizers; Air-preheaters; Super heaters and reheaters; Feed water heaters. General layout of thermal power plant; Site selection for thermal power plant; Coal as fuel, classification of coals, analysis of coal; Coal handling; Dead and live storage; Combustion of coal: coal burning methods, overfeed stokers, underfeed stokers, Pulverized fuels and burners. Ash handling and disposal; Dust collectors. Heat balance sheet for thermal power plants.

(16 hrs)

UNIT-III

Diesel Power Plants: Introduction; Field of use; Outline of diesel electric power plant; Different systems of diesel power plant; Supercharging of diesel engines; Performance of diesel power plant; Advantages and disadvantages of diesel plants over thermal power plants

Gas Turbine Plants: Elements of plant; Thermal refinements; Performance of plants; Gas turbine characteristics; Comparison with other plants; Combined steam and gas turbine power plants.

(8 hrs)

UNIT-IV

Economics of Power Generation: Introduction, Load curves, Different terms and definitions, Effects of variable loads on power plant design and operation. Cost of electrical energy; performance and operating characteristics of power plants; Load division among generators; Case studies/Latest developments/Sustainable technologies in Thermal Power Engineering.

(6 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

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1. Black & Veatch, “Power plant Engineering” CBS Publisher, 2005.
2. P K Nag, “Power plant Engineering” TMH.
3. Ballaney, “Thermal Engineering” Khanna Publisher.
4. Kearton, W.J. Pitman, “Steam Turbine Theory & Practice”.
5. Morse Power, “Plant Engineering”.
6. El-Wakil, “Power Plant Technology”.

Course Outcomes:

CO1: Understand the over view of boilers and power plant cycles.
CO2: Understand the operations of steam turbines and steam power plants.
CO3: Analyze the operations of diesel and gas turbine power plants.
CO4: Rectify the general challenges in thermal power plants

MECHANICAL ENGINEERING DEPARTMENT
PIPE326: SOLAR ENERGY

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course
NA

UNIT-I

Solar Radiation: Importance of renewable energy, energy statistics and power production scenario, Ministry of Power, Ministry of New and Renewable Energy, Energy Auditing and Management, Energy Conservation Act, Bureau of Energy Efficiency, Schemes and policies of PCRA. Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications.

(12 hrs)

UNIT-II

Solar Thermal Collectors: Solar Collectors, Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Flat-plate collectors: types; Thermal analysis; Thermal drying. Selective surfaces - Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization. One axis, Two axis, Solar tracking, Cylindrical, Spherical and Parabolic and Paraboloid concentrators. Composite collectors, Central receiver collectors. **(12 hrs)**

UNIT-III

Thermal Energy Storage: Sensible and latent heat storage, Chemical energy system, performance calculations. Natural and forced flow systems, Water heating systems for domestic, industrial and space heating requirements, Solar distillation **(8 hrs)**

UNIT-IV

Solar Refrigeration and Air Conditioning Systems: Introduction, Cooling load estimation, Solar refrigeration and air-conditioning systems, Solar liquid desiccant cooling. Solar solid desiccant cooling. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

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1. Duffie and Beckman, “Solar Thermal Engineering Process”.
2. H.P. Garg, “Advanced Solar Energy Technology”.
3. S.P. Sukhatme, “Solar Energy”.
4. Kearton, W.J. Pitman, “Steam Turbine Theory & Practice”.
5. J.S. Hsieh, “Solar Energy”.
6. P.J. Lunde, “Solar Thermal Engineering”.

Course Outcomes:

CO1: The students will be able to understand importance of Solar Energy among Renewable Energy Sources.

CO2: The students will be able to utilize different sources of renewable energy in engineering applications.

CO3: The students will be able to work on different contemporary methods to utilize solar energy, especially solar thermal power generation.

MECHANICAL ENGINEERING DEPARTMENT
PIPE327: POWER PLANT ENGINEERING

Pre-requisite: Thermodynamics , Heat Transfer

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This Course provides a simple understanding of the power plant engineering. The course contains the details of steam, diesel and gas thermal power plants, hydro power plants, along with solar in addition to the direct energy conversion. The importance of power generation and the environmental aspect of power generation are also being addressed in this course.

UNIT- I

Introduction: Introduction, Energy Scenario, Laws of Thermodynamics, Sources of Energy.

Vapour Power Cycles: The Carnot Vapor Cycle, Rankine Cycle: The Ideal Cycle for Vapor Power Cycles, Energy Analysis of the Ideal Rankine Cycle, and Deviation of Actual Vapor Power Cycles from Idealized Ones, Increase the Efficiency of the Rankine Cycle, Ideal Reheat Rankine Cycle, Ideal Regenerative Rankine Cycle, Open Feed water Heaters, Closed Feed water Heaters, Second-Law Analysis of Vapor Power Cycles, Problem Solving.

(10 hrs)

UNIT-II

Diesel Power Plants: Introduction; Applications, types of diesel plants, Combustion in CI engine, Performance Characteristics, supercharging of diesel engines, Advantages and disadvantages of diesel plants over thermal power plants, Problem Solving.

Gas Power Plant: Gas Turbine Power Plant, Closed and Open Cycle Plants, Advantages & Disadvantages of a GT Plant, Analysis of GT Plant, effect of operating variables on cycle like intercooling, reheating, Regeneration, Components of Gas Turbine Power Plants like Centrifugal Compressors**,** combustor, Gas Turbine blade cooling, Gas Turbine Fuels, Gas Turbine materials, Problem Solving.**:**

(10 hrs)

UNIT-III

Steam Turbine: Introduction, Impulse Turbines, Velocity Diagrams, Diagram work, Diagram Efficiency, Graphical Method, compounding of steam turbines, pressure compounding, velocity compounding, Reaction Turbines, Turbine Governing and control, problem solving.

Steam (Thermal) Power Plants: Boiler, Indian Boiler Regulations, Types of Steam Generators, Classifications, Performance of Boilers, Boiler Mountings & Accessories, Heat Absorption in water tubes and types, forced circulation system, water walls, Economizers, Superheaters, Reheaters, Air Preheaters, Fluidized Bed Boilers, Ultra Supercritical Technology, coal, coal Analysis, Coal Properties, overfeeding stokers, underfeeding stokers, burners. Problem Solving.

(10 hrs)

UNIT-IV

Hydroelectric Power Plants: Introduction, Advantages & Disadvantages, Selection of site for a Hydroelectric Plant, Hydrological Cycle, Hydrographs, Essential elements of a Hydroelectric power plant, Classifications, Hydraulics Turbine, Turbine Size, Pelton Wheel, Degree of Reaction, Francis Turbines, Propeller and Kaplan Turbines, Specific Speed, Cavitation, Turbines, Problem Solving.

Non-Conventional Power Generation: Solar Thermal power plants, Solar Photovoltaic power plants, advantages, factor affecting performance.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books / Videos

1. P K Nag, Power Plant Engineering, McGraw Hill.
2. Prof. S. Banerjee IIT Kharagpur, Energy Resources & Technology, NPTEL Video course (https://nptel.ac.in/syllabus/108105058/)
3. Prof. Ravi Kumar, Steam and Gas Power Systems (Video) (https://nptel.ac.in/syllabus /112107216/)
4. Morse, Power Plant Engineering.
5. Domkundwar, Power Plant Engineering.
6. P.C. Sharma, Power Plant Engineering.
7. El-Wakil, Power Plant Technology.

Course Outcomes:

CO1: Understand the over view of power plant.

CO2: Calculate Understanding the components of Diesel and gas turbine power plant and its requirement.

CO3: Analysis of super and ultra-critical power plant for need of power generation.

CO4: Understand the renewable technology and its future need.

MECHANICAL ENGINEERING DEPARTMENT
PIPC331: WORK STUDY AND ERGONOMICS (P)

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
0	0	2	1	24

Brief description about the course:
Work study and ergonomics is a subject in Production and Industrial Engineering. Its practical component focuses on applying the concepts of techniques like method study and work measurement to understand human work potential in terms of time spend for completing a task, looking at ways to make the task simpler and easy so as to increase productivity and efficiency. Work study is used for finding ways of increasing job performance, optimizing usage of plant and machinery and standardization of work methods.

List of Experiments:
1. To study and improve the Nut-Bolt-Washer Assembly Method.
2. To perform the Work Sampling Exercise.
3. To perform Stop Watch Time Study for Production of a Machine Component.
4. To study anthropometric measurement and its utility.
5. To study various rating factors and find standard time.
6. To draw a Flow Process Chart with time estimates for a simple welding process.
7. To draw a Two Handed Process Chart for a simple process of a job preparation on a Lathe Machine.
8. To draw p, $\overline{X}$ and R charts for a given sample of product to check their acceptance.
9. To study various plant layouts and suggest improvements in existing Machine shop Layout.
10. A case study on ABC/VED analysis.
11. To study Effect of Noise, Light, Heat on human efficiency in work environments

Course Outcomes:
1. Develop the understanding of Work Sampling Exercise.
2. Develop the understanding of Stop Watch Time Study for Production of a Machine Component.
3. Develop the understanding of anthropometric measurement and its utility.
4. Develop the understanding of various rating factors and find standard time.
5. Develop the understanding of Flow Process Chart with time estimates for a simple welding process.
6. Develop the understanding of Two Handed Process Chart for a simple process of a job preparation on a Lathe Machine.
7. Draw various Control Charts (p, $\overline{X}$ and R chart) and understand their applications.

8. Develop the understanding of basic concepts of various plant layouts and suggest improvements in existing Machine Shop Layout.
9. Develop the basic understanding of Inventory Control Management through case study on ABC/VED analysis.
10. Design work environment by applying knowledge of effect of environmental conditions on human performance.

B. Tech. (PIE) 7th Semester

CODE	COURSE	L	T	P	Credits
PIPC401	Logistics & Supply Chain Management	3	0	0	3
PIPC402	Non Conventional Machining	3	0	0	3
PIPC403	Metrology & Measurements	3	0	0	3
PIPE***	Any one subject from Group VII	3	0	0	3
PIPE***	Any one subject from Group VIII	3	0	0	3
OE*		3	0	0	3
PIPC414	Metrology & Measurements (P)	0	0	2	1
PIIC415	Internship/Training/Project Viva-Voce (4-6 weeks duration after 6th semester examination)				2
	Total Credits				21

PROGRAM ELECTIVES

GROUP - VII		GROUP - VIII	
CODE	COURSE	CODE	COURSE
PIPE404	Computer Aided Process Planning	PIPE409	Project I
PIPE405	Advanced Welding Technology	PIPE410	Lean Manufacturing
PIPE406	Total Quality Management	PIPE411	Additive Manufacturing
PIPE407	Project Management	PIPE412	Artificial Neural Network
PIPE408	Nuclear Engineering	PIPE413	Introduction to MATLAB Programming

MECHANICAL ENGINEERING DEPARTMENT

PIPC401: LOGISTICS & SUPPLY CHAIN MANAGEMENT

Pre-requisite: None

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Supply chain is a network of businesses and activities that takes a product from raw material suppliers to end consumers. By definition, logistics refers to the processes of acquiring, transporting, and storing resources along the supply chain and logistics.This course provides the understanding of supply chain management and its knowledge application in corporate world.

UNIT-I

Objectives of supply chain, Stages of supply chain, Supply chain process cycles, Push/pull view of supply chain processes, Importance of supply chain flows, Examples of supply chain, Strategic decisions in supply chain management. Supply Chain Performance, Supply chain strategies, achieving strategic fit, Product life cycle, Supply Chain drivers and Obstacles, four drivers of supply chain – inventory, transportation, facilities, and information, Obstacles to achieve strategic fit. **(8 hrs)**

UNIT-II

Planning Demand and Supply in a Supply Chain: Role of forecasting in a supply chain, Forecasting methods in a supply chain, Basic approach to demand forecasting, Aggregate planning resources. Managing economies of scale in a supply chain, Role of cycle inventory in a supply chain.

(10 hrs)

UNIT-III

Transportation and Coordination in a Supply Chain: Facilities affecting transportation decisions, Transport selection, Modes of transportation and their performance characteristics, Trade-offs in transportation decision, Making transportation decisions in practice, Models for transportation and distribution, Third party logistics (3PL). Coordination in a Supply chain, Lack of supply chain coordination and the Bullwhip effect, Effect of lack of coordination on performance, Obstacles to coordination, Achieving coordination in practice.

Source Management and IT in Supply Chain: Inventory management in supply chain, Information technology in supply chain, Typical IT solution, Reverse supply chain, Reverse supply chain Vs. Forward supply chain

(10 hrs)

Advanced cases in Supply Chain: Green, Lean, Sustainable, Global and Agile supply chain Management, Quality in Supply Chain. Integration and Collaborative Supply Chain, Circular Supply Chain Management. Case Studies such as Newspaper, Mumbai Tiffanwala, Disaster Management, Organic Food, Fast Food, Hostel Mess etc. **(12 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Christopher Martin, "Logistics and Supply Chain Management", Pearson Education Asia.
2. Chopra Sunil and Meindl Peter, "Supply Chain Management – Strategy, planning and operation's", Pearson Education, Asia.
3. Kapoor K K, KansalPurva, "Marketing logistics: A Supply Chain Approach", Pearson Education Asia.
4. Mohanty, R.P and Deshmukh, S.G., "Supply Chain Management", Pearson Education Asia.
5. Fawcett, S. E., Ellram, L. M and Ogden, J. A., "Supply Chain Management" Pearson Education Asia.
6. Dixit Garg, Sunil Luthra and Sachin Mangla., "Supply Chain and Logistics Management". New Age International Publishers

Course Outcomes:

CO1: Understand the decision phases and apply competitive & supply chain strategies.
CO2: Understand drivers of supply chain performance.
CO3: Analyze factors influencing network design and forecasting in a supply chain.
CO4: Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

MECHANICAL ENGINEERING DEPARTMENT
PIPC402: NON CONVENTIONAL MACHINING

Pre-requisite: PT-III

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Non-conventional Machining introduces the basic concepts and applications of various Non-Conventional Machining processes. The course is also intended to demonstrate the importance of Non-Conventional Machining in the present day manufacturing scenario. This course enables the students to understand their fundamental concepts and importance of different Non-Conventional Machining processes.

UNIT-I

Introduction to Non-Conventional Machining Processes, Introduction to use of non-conventional processes for micro-machining.

Mechanical Material Removal Processes (AJM, USM and WAJM): Abrasive Jet Machining (AJM): Introduction to abrasive jet machining (AJM), Mechanics of AJM, AJM process parameters Components of AJM, Material removal rate.

Ultrasonic Machining (USM): Basics of USM processes, Mechanics of USM, Process parameters of USM, Shaw's model of USM mechanics, Material removal rate, Ultrasonic machining setup.

Water Abrasive jet machining (WAJM): Introduction to WAJM including basic principle and MRR estimation, Classification of costs, Total manufacturing cost.

(12 hrs)

UNIT-II

Nano-finishing processes: Introduction to nano-finishing and need of nano-finishing, Abrasive Flow Finishing (AFF), Introduction to AFF, AFF machine elements, Magnetic Abrasive Finishing (MAF), Introduction to MAF, Elements of MAF, Setup and process parameters for AFF and MAF, Parametric analysis and applications of MAF and AFF.

(8 hrs)

UNIT-III

Electrochemical Machining Process (ECM): Basic Principle of Electrochemical Machining, Estimation of MRR in ECM, MRR in multiphase alloys, Kinematics and Dynamics for ECM

process, Basics of Electrochemical drilling, Basics of Electrochemical Grinding, Basics of Electro stream drilling, Process parameters from Electro-stream drilling and Electrochemical Grinding, Electrochemical turning, Electrochemical Milling, Electrochemical deburring, Electrochemical boring.

(8 hrs)

UNIT-IV

Thermal Material Removal Processes: Electro-discharge machining: Electro-discharge machining (EDM), Process parameters of EDM, Mechanics of EDM, Theoretical estimation of MRR in EDM, Material removal in EDM, Surface finishing and machining accuracy in EDM, Taper and overcut in EDM, Effect of EDM on surface hardness, Electrode and dielectric fluid.

Electron Beam Machining (EBM): Introduction to electron beam machining, Comparison of E-beam machining with other thermal processes, Setup for EBM, Power requirement in E-Beam.

Laser Beam Machining (LBM): Introduction to Lasers and Laser beam machining, Types of lasers and feedback mechanisms in Lasers, Mechanics of material removal, Time of machining.

(12 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

5. Hassan Abdel, Gabad El Hoffy; Advanced manufacturing processes, McGraw Hill.
6. V. K. Jain, Advance Machining Processes, Allied Publisher Bombay.
7. P. C. Pandey, H. S. Shan; Modern machining processes, Tata McGraw-Hill Education.
8. E. J. Weller; Non-traditional machining processes, Society of Manufacturing Engineers, Publications.
9. Ghosh and Mallik; Manufacturing Science, EWP Private Ltd.
10. Stephen P. Campbell; The Science and Engineering of Micro-fabrication, Oxford university press.

Course Outcomes:

CO1: Understand the history and evolution of Non-Conventional Machining and recent developments in this field.

CO2: Visualize the concepts and applications of Non-Conventional Machining processes.

CO3: Elemental knowledge about material removal rate, surface finish and different process parameters of Non-Conventional Machining.

CO4: Basic concepts of Non-Conventional Machining, its principles for selection for materials and its application on a large scale.

MECHANICAL ENGINEERING DEPARTMENT
PIPC403: METROLOGY & MEASUREMENTS

Pre-requisite: Production Technology-II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Metrology is a fundamental subject in production and industrial engineering that deals with the science of measurement and its application in precision manufacturing processes. It encompasses the principles, techniques, and tools used for accurately measuring various physical quantities, such as length, angle, surface finish, temperature, pressure, and more. The objective of metrology is to ensure the quality and precision of manufactured products by establishing reliable measurement standards and practices. This subject provides production and industrial engineering students with a comprehensive understanding of measurement principles and their practical implementation in industries.

UNIT - I

Necessity and Importance of Metrology, Precision Measurement – Its need, Classification of Measuring Instruments, Classification of Methods of Measurements.

Calipers, Vernier Calipers, Vernier Height Gauge, Vernier Depth Gauge, Micrometers - Description of micrometer, types of micrometers, Advantages and Limitations of commonly used Precision Instruments.

Angular Measurements, Instruments for Angular Measurement -Protractors, Sine bars, Sine table, Sine center, Angle gauges, Spirit level & Clinometers, Taper Measurement - Gauges for Tapers, Taper Measuring Instruments. **(10 hrs)**

UNIT – II

Principles of Mechanical Measuring Instruments, Principles of Optical Instruments - Reflection, Refraction, Lenses, Interference, Optical prisms & Optical projectors.

Comparator, Types of Comparators, Mechanical Comparators, Optical Comparators, Electrical and Electronic Comparators, Pneumatic Comparators, Methods of Measuring Surface Finish, Profile Projector, Combination set, Surface Plate.

Limits, Fits and Tolerances, Limit Gauges and gauge design, Miscellaneous Gauges. **(10 hrs)**

UNIT - III

Specifications of screw Thread, Measuring Elements of a Screw thread, External Screw Thread Measurements, Internal Screw Thread Measurements, Screw Thread Gauges.

Gear Tooth Terminology, Measurement of Gear tooth thickness, Measurement of gear tooth Profile, Measurement of pitch. Roundness and Circularity, Measurement of Circularity-Devices Used, V-block and dial indicator, Precision measuring instruments. **(10 hrs)**

UNIT – IV

Sustainable practices in industrial metrology and measurements, emerging trends in metrology like use of laser and X-ray scanning, use of sensors for increased speed and digitalization of measuring devises, optical holographic recording and its re-construction, Surface engineering - organic and inorganic coatings, case study of precision manufacturing equipment or units. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. M. Mahajan, "A Text Book of Metrology", Dhanpat Rai Publications.
2. A.K. Bewoor & V.A. Kulkarni, "Metrology and Measurements", McGraw Hill Education.
3. N.V. Raghvendra & L. Krishnamurthy, "Engineering Metrology and Measurements", Oxford Higher Education.
4. O.P.Khanna, "Metrology and Instrumentation", Dhanpat Rai Publications.
5. R.K. Jain, "Engineering Metrology", Khanna Publications.

Course Outcomes

CO1: Students will select and demonstrate appropriate measuring equipment and devices for their use in precision manufacturing industries.

CO2: Students will evaluate and measure the different elements and surface asperities like surface finish, screw threads, gear tooth, circularity etc. using measuring devises.

CO3: Students will evaluate the limits and tolerances and will design the limit gauges.

CO4: Students will identify and understand the role of emerging trends and sustainable practices in metrology for the present precision engineering scenario.

MECHANICAL ENGINEERING DEPARTMENT
PIPE404: COMPUTER AIDED PROCESS PLANNING

Pre-requisite: PT-III

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The aims of this course are to develop an understanding of the underlying knowledge and related methods of Computer Aided Process Planning and to equip the students with the skills required in carrying out the process planning function in a computer integrated manufacturing environment.

UNIT-I

The Place of Process Planning in the Manufacturing Cycle: Process planning and production Planning-Process planning and Concurrent Engineering, CAPP, Group Technology, Structure of automated process planning system, feature recognition methods.

Part Design Representation: Design Drafting, Dimensioning, Conventional Tolerance, Geometric Tolerance, CAD-input/output devices, Topology, Geometric Transformation, Perspective Transformation, Data Structure, Geometric modelling for process planning, GT Coding, The OPITZ system, The MICLASS System.

(10 hrs)

UNIT-II

Process Engineering and Process Planning: Experience based planning, Decision table and Decision Trees, Process capability analysis, Process Planning, Variant process planning, Generative Approach, Forward and backward planning.

(10 hrs)

UNIT-III

Computer Aided Process Planning Systems: Logical Design of process planning- Implementation, Considerations-Manufacturing system components, Production Volume, No. of production families, CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

(10 hrs)

UNIT-IV

An Integrated Process Planning Systems: Totally integrated process planning systems: An Overview, Modulus Structure, Data Structure, Operation Report Generation, Expert process planning. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

11. Gideon Halevi, Roland D. Weill; Principle of process planning- A Logical Approach, Chapman & Hall.
12. T. C. Chang, Richard A. Wysk; An Introduction to automated process planning systems, Prentice Hall.
13. M. P. Groover; Automation, production systems, and computer-integrated manufacturing, 2nd ed., Prentice Hall, 2001.
14. M. P. Groover; Fundamentals of modern manufacturing: materials, processes, and systems, 2nd ed., John Wiley & Sons, 2002.
15. P.N. Rao, Computer Aided Manufacturing, Tata McGraw Hill Publishing Co.

Course Outcomes

CO1: Explain the importance of process planning.

CO2: Identify the link between OPTIZ and MICLASS system

CO3: Understand process engineering and process planning.

CO4: Know different computer aided process planning systems.

MECHANICAL ENGINEERING DEPARTMENT
PIPE405: ADVANCED WELDING TECHNOLOGY

Pre-requisite: Production Technology-III

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

Advanced Welding Technology is a subject in production and Industrial engineering that focuses on the study and application of advanced welding processes, techniques, and materials. It aims to provide students with an in-depth understanding of the latest developments in welding technology and equip them with the skills necessary to tackle complex welding challenges in industrial settings. Students will develop the skills necessary to select appropriate welding processes, optimize welding parameters, ensure weld quality, and address challenges associated with advanced materials and applications. This knowledge prepares them for roles in industries where welding plays a crucial role, such as automotive, aerospace, construction, and energy sectors.

UNIT-I

Arc physics, volt-ampere (VI) characteristics, duty cycle, AC/DC, CC and CV power sources, metal transfer modes in welding, residual stresses, heat flow and welding metallurgy, weldability of SS and Ni-base alloys. **(10 hrs)**

UNIT-II

High-energy density welding processes: concept, mechanism and applications of high density welding processes; plasma arc welding, laser beam welding; fundamentals, types of lasers, electron beam welding and its recent developments. **(10 hrs)**

UNIT-III

Solid state welding processes; friction stir welding, ultrasonic welding, diffusion bonding, Non-conventional welding; underwater welding, microwave hybrid joining, adhesive weld bonding, magnetic impelled arc butt welding(MIAB). **(10 hrs)**

UNIT-IV

Advanced tungsten inert gas welding: high frequency pulsed GTAW, cold and hot wire feeds, multi-cathode GTAW, Pulse & Synergic-MIG, cold-metal transfer (CMT) welding, narrow-groove welding techniques; joint preparation, narrow gap GTAW torch, sustainable practices in advanced welding like hot wire laser welding, case study of pressure vessels welding – dissimilar welding, thick section NG welding.

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Hoffman. D.J., Welding, 2nd Ed., Pearson.
2. Little, R.L., Welding and Welding Technology, McGraw-Hill.
3. Norrish, J., Advanced Welding Processes, Woodhead Publishing.
4. Misra, R., Friction Stir Welding and Processing: Science and Engineering, Springer.
5. AWS Welding Handbooks, 9th Edition, Vol. 1 & 3, AWS Publications.
6. Kou, S., Welding Metallurgy, Wiley-Interscience.
7. Parmar, R.S., Welding Engineering and Technology, Khanna Publishers.
8. Nadkari, S. V., Modern Arc Welding Technology, 2nd edi. (2005), Oxford & India Book House Pvt. Ltd.
9. Robert W. Messler, Jr., Principles of Welding – Processes, Physics, Chemistry, and Metallurgy, (2014 reprint) Wiley-UCH Publisher

Course Outcomes

CO 1: Students will select and demonstrate appropriate use of power sources for given welding conditions.

CO 2: Students will understand and identify the nature of residual stresses during welding.

CO 3: Students will select and design the thick section welding using various welding techniques and processes.

CO 4: Students will interpret and apply the knowledge of conventional and advanced welding processes for the present engineering and fabrication scenario.

MECHANICAL ENGINEERING DEPARTMENT
PIPE406: TOTAL QUALITY MANAGEMENT

Pre-requisite: QCA

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course:

Total Quality Management is a business improvement strategy to management that focuses on continuous improvement, customer satisfaction, and the involvement of all employees in the organization. This course provides a holistic and comprehensive management philosophy that aims to enhance the quality of products, services, and processes within an organization.

UNIT-I

Introduction: Products and services, quality and productivity, dimensions of quality: manufacturing and service, continuous improvement**,** quality management practices, need of TQM, concept of TQM, elements of TQM, pillars of TQM, companywide organization for quality management, quality awards.

(8 hrs)

UNIT-II

TQM Leadership and Techniques: Motivation and involvement for total quality, strategic quality planning, corporate culture, total employee involvement, total commitment, role of information in total quality, soft and hard practices of TQM, quality circle, seven QC tools, failure mode effect analysis, gemba kaizen, 6S, benchmarking, zero defects, PDCA cycle.

(12 hrs)

UNIT-III

TQM Framework and Systems: Success factors and obstacles in TQM implementation, Implementing TQM, TQM framework, quality management systems; ISO 9000 Series of standards, ISO 9001 structure, ISO 14000 series standards, concepts of ISO 14001, requirements and benefits of ISO 14001.

(12 hrs)

UNIT-IV

TQM Case and Sustainable Practices: Sustainable TQM, TQM 4.0, lean-TQM, total productive maintenance, TQM case studies in manufacturing and service sector

(8 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Besterfield, D.H, Michna, C.B, Besterfield, G. H and Sacre, M.B, "Total Quality Management" Pearson Education Asia.
2. Mukherjee, P. N., "Total Quality Management" Prentice Hall of India.
3. Rajaram, S., "Total Quality Management" Biztantra.
4. Ramasamy, S. "Total Quality Management" Mc Graw Hill Education.
5. Luthra, S, Garg, D, Aggarwal, A, Mangla, S.K., Total Quality Management Principles, Methods, and Applications, CRC Press

Course Outcomes

CO1: Understand the fundamentals of quality management practices.

CO2: Discuss the need of customer expectations, employee involvement and supplier partnership.

CO3: Apply the TQM tools and techniques to improve the product and process quality.

CO4: Describe quality Management system standards and certification process.

MECHANICAL ENGINEERING DEPARTMENT
PIPE407: PROJECT MANAGEMENT

Pre-requisite: PPC

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

This course suggests ways of improving project appraisal and capital budgeting practices and also describes and evaluates business practices in various areas. Further, it discusses key principles and techniques for evaluating capital expenditure proposals, as well as strategic, qualitative and organizational considerations impacting capital budgeting decisions

UNIT-I

Characteristics of a project types of projects, Project Management Body of Knowledge(PMBOK), role of project manager and his qualities, project organization and benefits, idea generation, needs ofsociety, project lifecycle, project charter, project sponsor.

Project Planning: Customer needs, stake holder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude.

(**10hrs)**

Structure: Project selection methods, breakeven analysis, DCFmethods, project implementation, estimation, cost, price, value, scheduling, bar charts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management, decision trees.

(**10hrs)**

UNIT-III

Vendor selection methods, resource planning and allocation, availability and constraints of resources, Project scope, project cost and quality, project reports, project audits, Project evaluation, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis. (**10hrs)**

UNIT-IV

Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health, human and environment all factors, project finance.

A project management case study: that showcases the challenges that the organization faced, the solutions adopted, and the final results. (**10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation, and Review", TATA McGraw Hill, New Delhi,2010.
2. K. K. Chitkara," Construction Project Management Hardcover" TATA McGraw Hill, New Delhi,2010.
3. Harold Kerzner, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", 13th Edition, Wiley, NewYork.
4. R.Panneerselvam, "Project Management",PHI, India
5. Nagarajan, K, "Project Management", New Age International Pvt Ltd, India.

Course Outcomes

CO1: Discuss complete structure of project management and analyze the scope of project planning.

CO2: Identify different project selection methods.

CO3: Explain the importance of procurement and its techniques.

CO4: Define the guidelines required for project control and its controlling techniques.

MECHANICAL ENGINEERING DEPARTMENT
PIPE408: NUCLEAR ENGINEERING

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

NA

UNIT-I

Concepts of Nuclear Physics: The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements. Advantages of using neutron, neutron moderation, fission chain reaction, thermalisation of neutrons, fast neutrons, prompt and delayed neutrons, fission products. **(10 hrs)**

UNIT-II

Reactor Materials: Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion, thermonuclear reaction, fusion bomb. Fissile & fertile materials, cladding & shielding materials, moderators, coolants. **(08 hrs)**

UNIT-III

Nuclear Reactors and Safety Considerations: Basic principles, fuel assembly, neutron balance, reactor kinetics, reactor coefficients, reactor stability, excess reactivity, Xenon poisoning, burnable absorbers, reactivity control, heat balance, production& transfer of heat to the coolant, structural considerations. Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste. **(20 hrs)**

UNIT-IV

Health Physics & Radio-isotopes: Radiation: units, hazards, prevention, preparation of radio-isotopes& their use in medicine, agriculture & industry. **(02 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

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1. Duffie and Beckman, “Solar Thermal Engineering Process”.
2. H.P. Garg, “Advanced Solar Energy Technology”.
3. S.P. Sukhatme, “Solar Energy”.
4. Kearton, W.J. Pitman, “Steam Turbine Theory & Practice”.
5. J.S. Hsieh, “Solar Energy”.
6. P.J. Lunde, “Solar Thermal Engineering”.

Course Outcomes:

CO1: Understand the concepts of neutron physics and various nuclear Processes involved in Nuclear Power Plants.
CO2: Calculate heat generation from nuclear reaction.
CO3: Design and analyze the performance of nuclear power plants.
CO4: Get acquainted with applications of radioactivity.
CO5: Appreciate the hazards associated with radioactivity and the necessity of waste disposals.

MECHANICAL ENGINEERING DEPARTMENT
PIPE410: LEAN MANUFACTURING

Pre-requisite: PPC

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course:

Lean Manufacturing covers a number of tools, methods and techniques for reduction or elimination of the eight types of waste in any manufacturing system. It includes the housekeeping tools like 5-S, Inspection and visualization tools (Pareto chart, Kanban, Cause and effect diagram), tools for evaluation of efficiency (O.E.E.), for improvement of efficiency (SMED, Kaizen) and quality (Robust Design). This course is very useful for understanding the basic concepts of lean manufacturing and to apply these for productivity and quality improvement in any manufacturing organization.

UNIT-I

Definition of lean Manufacturing, Basic Concepts, Emergence of lean and agile manufacturing, Eight Types of waste in manufacturing, Tools for waste elimination

Tools of Lean Manufacturing: 5-S, Flexible cells, Cause and effect diagram, Pareto Chart, Poka Yoke, Kanban, SMED, Design for Manufacturability, JIT system, Kaizen.

(10 hrs)

UNIT-II

Total Productive Maintenance: Principles and Eight Pillars of TPM, Six major losses, Computation of Overall equipment effectiveness, TPM implementation Procedure.

Value Stream Mapping: Introduction, Primary Icons: Customer and Supplier, Production control, Process, Push, Pull, Data box icons. Secondary icons, VSM development plan, case study.

(12 hrs)

UNIT-III

One Piece flow and visual management: Lean Manufacturing through One-piece flow, fundamentals, implementation procedure, Visual management tools for eliminating eight wastes Quality Circles: Quality circle Structure, Characteristics of QC's, Development of QC's, Basic problem solving techniques **(10 hrs)**

UNIT-IV

Quality tools and technique: Costs of quality, Taguchi quality loss function, Taguchi's robust design methodology for quality improvement, Failure mode and effect analysis. Case studies.

(8 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Lean and agile manufacturing, S.R. Devadasan and V. Sivakumar, PHI Learning Pvt Ltd, 2012,
2. Quality Management by Kanishka Bedi, Oxford University Press, 2006.
3. The Toyota way, Jeffery K Liker, MCGrawhill Education, 2004.

Course Outcomes

CO1: Understand the various lean manufacturing concepts for waste reduction in industry.

CO2: Evaluate the Equipment efficiency and quantify the major equipment related losses in manufacturing industries

CO3: Apply the visual management concepts for improvement of process efficiency

CO4: Apply the robust design methodology for product design or process performance improvement.

MECHANICAL ENGINEERING DEPARTMENT
PIPE411: ADDITIVE MANUFACTURING

Pre-requisite: MD, PT-III

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

Additive Manufacturing is one of the pillars in Industry 4.0 technology. AM has changed the way of manufacturing the components for various applications. This course will have following learning objectives This course provides the fundamental knowledge of additive manufacturing (AM) and applications in different Industries.

UNIT-I

Overview – History – Need- of Additive Manufacturing, Classification of AM processes and 7 families of AM, fundamental engineering aspects. Difference between Additive and Subtractive Manufacturing, AM benefits, 3D printing and additive manufacturing, Generic AM Process, Rapid Prototyping Product development, AM applications timeline evolution, Additive Manufacturing applications in Aerospace, Automotive, Electronics, defence and Biomedical. Industrial revolutions, AM in Industry 4.0, current development in the field of AM. **(8 hrs)**

UNIT-II

CAD for AM: Basic Concept: Digitization techniques – Model reconstruction – Data processing for AM Technology: CAD model preparation – Part orientation and support generation – Model slicing –Tool path generation (preparatory (G) and miscellaneous (M) code generation) – Softwares for AM Technology- Cura, Mimics, Magics. STL file generation, STL file format-ASCII encoding and Binary encoding, defects in STL file, STL file repair, Design for Additive Manufacturing- Levels of AM deployment, Business impact of industrial AM, Innovative product design, Reverse Engineering, Application Geometric Model Development, Digitization techniques- Contact and Non-Contact Methods. **(10 hrs)**

UNIT- II

AM Processes: Fused deposition modelling (FDM)- Principle, process parameters of FDM, Cause effect diagram, advantages, applications and defects in FDM printing, Stereolithography (SLA)-Binder Jetting-Material jetting-Powder bed fusion AM processes involving sintering and melting- Principle, process, advantages, effect of process parameters and applications, Directed

energy deposition-Sheet lamination: Principle, process, advantages, effect of process parameters and applications **(12 hrs)**

UNIT-IV

Material Science Aspects and Case Study: Different materials used in AM- polymers filaments materials (ABS, PLA, PCs, PEI, Nylon and other), metals (SS316L, Inconel 625 and 718, AlSi10Mg), multifunctional and graded materials. Effect of AM process parameters on built parts, Mechanical properties and Metallurgical characterization of key materials, A case study based on experimental development of 3D components as a mini project. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific, 2010.
3. John O. Milewski, Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry, Springer- 2017
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
5. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Course Outcomes

CO 1: To comprehend fundamentals of Additive manufacturing (AM) with different types of AM process.

CO 2: To apply various designing and slicing techniques to create tool path for AM.

CO 3: To comprehend fundamentals of different AM processes classified based on ASTM.

CO 4: To acquire knowledge of different materials and create AM components by applying fundamental knowledge of different AM process.

MECHANICAL ENGINEERING DEPARTMENT
PIPE412: ARTFICIAL NEURAL NETWORK

Pre-requisite: NIL

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course introduces the Neural Networks and Fuzzy logic. In today's highly integrated world, these techniques are powerful means for obtaining solutions to problems quickly and accurately. These techniques build computationally intelligent systems that possess human like abilities to reason, learn and handle the uncertainty and vagueness often inherent in real world problems. These can be used to solve complex practical problems for which conventional mathematical and analytical methods are inefficient.

UNIT-I

Introduction of Artificial Neural Network, Advantages, Biologic neural network, Comparison between Artificial and Biological Network, Basic building blocks of Artificial Neural Network, Artificial Neural Network Terminologies, Fundamental models of Neural Network (McCulloch-Pitts Neuron Model for AND, OR, XOR, ANDNOT function, Learning Rules (Hebbian, perceptron, delta), Hebb Net, Perceptron networks, Adaline , Madaline

(12 hrs)

UNIT-II

Associative memory models (Auto associative network, Hetero associative Memory Network) Training by (1) Hebb Rule (2) Outer Product Rule. Competitive networks(Hamming Network, Maxnet, Mexican Hat Network) Multi-layer Feed –forward Neural Network(Architecture, Learning Method, Back propagation Method, Design issues of Artificial Neural Network , Applications of Feed-forward Networks

(1**4 hrs)**

UNIT-III

Introduction to Fuzzy logic, Fuzzy versus crisp, Crisp set Theory, operation on crisp sets, properties of crisp sets, crisp relation (Cardinality, Operations and properties of crisp Relations), Fuzzy sets: Membership function, basic fuzzy set operations, properties of fuzzy sets, fuzzy relations (Cardinality, Operations, Properties of fuzzy relations

(8 hrs)

UNIT-IV

Crisp logic, Predicate Logic, Fuzzy logic (Fuzzy quantifiers, Fuzzy inference), Fuzzy rule based system-Formation of Rules, Decomposition of rules, Aggregation of Fuzzy rules) De-fuzzification methods, Air conditioner Controller, Washing Machine controller

(6 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text and Reference Books:

1. Saroj Kauhik and Sunita Tiwari, Soft computing fundamentals, Techniques and Applications , McGraw Hill Education Private Limited
2. S. Rajasekaran & G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI, 2003.
3. S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India, 2007.
4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2007.
5. S. N. Sivanandam , Sumuthi & S. N. Deepa, Introduction to Neural Networks using MATLAB
6. S. N. Sivanandam , Sumuthi & S. N. Deepa, Introduction to fuzzy logic using MATLAB
7. Timothy, J.Ross Fuzzy Logic with Engineering Applications,Wiley,2016

Course Outcomes

CO1: Student will be familiar with fundamental theory, concepts and models of neural network

CO2: Student will be able to apply neural networks to prediction and pattern classification problems

CO3: Student will be familiar with fundamental theory, concepts of fuzzy logic

CO4: Students will be able to apply fuzzy logic to solve engineering problems having uncertainty

MECHANICAL ENGINEERING DEPARTMENT
PIPE413: INTRODUCTION TO MATLAB PROGRAMMING

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
2	0	2	3	40

Brief Description about the course

MATLAB is an object-oriented high-level interactive software package for scientific and engineering numerical computations. Its name stands for matrix laboratory. MAT - LAB enables easy manipulation of matrix and other computations without the need for traditional programming. MATLAB's basic data element is the matrix. In MATLAB programming, the main features of the MATLAB integrated design environment and its user interfaces - the MATLAB Desktop, Command window and the Graph Window ,How to do simple and complex calculation using MATLAB. How to automate commands with scripts ,How to Increase automation by encapsulating modular tasks as user-defined functions and the tools that are essential in solving engineering problems are covered

UNIT-I

Basic Features and The MATLAB Desktop: Introduction to MATLAB, MATLAB Windows, Variables, Keywords, Special variables, Managing the workspace, Complex Numbers, Number display formats, Mathematical functions, MATLAB search path, Script M-File use, Use of Special functions-disp, input, pause, waitfor buttonpress, Comments, Block comments, punctuation and aborting execution,

Arrays and Array Operations: Simple arrays, Array addressing, Array construction, array orientation,, scalar-array mathematics, array-array mathematics, standard arrays, array manipulation, array sorting, subarray searching, array manipulation functions, array size, multidimensional arrays (**10 hrs)**

UNIT-II

Numeric data types, Cell Arrays and Structures: Numeric Data types- integer data types, floating point data types, cell array creation, cell array manipulation, retrieving cell array content, cell functions, structure creation, structure manipulation, retrieving structure content, structure functions

Relational and Logical Operations: Relational operators, logical operators, operator precedence, relational and logical functions **(10 hrs)**

UNIT-III

Control Flow: Control flow-for loops, while loops, if-Else-End, Switch-Case, Try-Catch block
Functions: M-FILE function construction rules, input and output arguments, nested functions, Function handles and anonymous functions **(10 hrs)**

UNIT –IV

Two & Three Dimensional Graphics and Debugging: Two dimensional graphics- The plot function, Line style, Markers, Colors, plot grids, axes box and labels, Customizing plot axes, Multiple plots, Multiple figures, Subplots, Interactive plotting tools, Specialized 2D plots, Three-Dimensional graphics- Line plots, Scalar functions of two variables, Mesh plots, Surface plots, Contour plots, how to do Debugging in MATLAB, Native data files, directory management
Matrix Algebra and Data Analysis: Set of Linear Equations, Matrix functions, Sparse Matrices, Basic Statistical Analysis, Basic Data Analysis, Data Analysis and Statistical Functions

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books

1. Mastering MATLAB 7 BY Duane Hanselman, Bruce Lttle field
2. MATLAB Programming for Engineers by Stephen J. Chapman
3. Introduction to MATLAB for Engineers by William J. Palm III
4. A Guide to MATLAB: For Beginners and Experienced Users by Brian R. Hunt

Course Outcomes

CO1: Students will become familiar with fundamental operations in MATLAB, matrix generation and manipulation
CO2: Students will become familiar with cell arrays, Structures , Logical and Relational Operators
CO3: Students will be able to use control loops and functions
CO4: Students will be able to use MATLAB graphic feature and apply Matrix Algebra and Data Analysis

MECHANICAL ENGINEERING DEPARTMENT
PIPC414: METROLOGY & MEASUREMENTS (P)

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
0	0	2	1	24

Brief description about the course:

Metrology Practical is a hands-on subject in production and industrial engineering that complements the theoretical knowledge gained in the metrology course. It focuses on providing students with practical skills and experience in using various measurement instruments, techniques, and tools. Through laboratory sessions and experimentations, students learn how to perform accurate measurements, analyze measurement data, and apply measurement principles in precision manufacturing environment.

List of Experiments:

1. Introduction to metrology lab, its significance and various measuring instruments.
2. To measure the angle of taper rod using sine bar and slip gauges.
3. To measure the angle and width of V-groove using optical bevel protractor.
4. To measure the gear tooth thickness by using gear tooth Vernier caliper.
5. To measure the element of screw thread using digital tool maker microscope.
6. To understand the construction and working principle of standard basic instruments, straight edge radius gauge, screw pitch gauge, feeler gauge.
7. To find unknown angle of component using sine bar and verify it by using bevel protractor.
8. To compare the flatness of a given surface using optical flats.
9. To measure screw thread elements by using optical profile projector.
10. To measure the surface roughness of a machined surface using surface profilometer.

Course Outcomes

CO1: The student shall be measuring the various parameters like length, height, angle, displacement, flatness etc., by using various instruments like Vernier calipers, micrometer, dial indicator, etc.

CO2: The student shall be able to measure the threads, gear tooth profiles and surface roughness using appropriate instruments and analyze the data.

CO3: The student shall be able to check alignment of various components in various mechanisms using advanced scientific tools.

CO4: The students will be able to work in quality control and quality assurances divisions in industries.

B. Tech. (PIE) 8th Semester

CODE	COURSE	L	T	P	Credits
PIIC414	Entrepreneurship and Start-ups	3	0	0	3
PIPC415	Reliability and Maintenance Engineering	3	0	0	3
PIPE***	Any one subject from Group IX	3	0	0	3
PIPE***	Any one subject from Group X	3	0	0	3
OE*		3	0	0	3
	Total Credits				15

PROGRAM ELECTIVES

GROUP – IX		GROUP - X	
CODE	COURSE	CODE	COURSE
PIPE416	Product Design and Development	PIPE420	Project II
PIPE417	Mechanical Metallurgy	PIPE421	Advanced Materials
PIPE418	Six Sigma: Concepts and Methodology	PIPE422	Hybrid Machining Methods
PIPE419	Tool Engineering	PIPE423	Micro and Nano Fabrication Methods

MECHANICAL ENGINRRTING DEPARTMENT
PIIC414: ENTREPRENEURSHIP AND START-UPS

Prerequisite: NIL

L	T	P	Credits	Total Contact Hours
3	-	-	3	40

Brief Description about the course

This course make Students learn about themselves, their decisions, and their goals to determine how entrepreneurship can play a role in their lives. Learn entrepreneurship from an economic perspective, the concepts of environmentally sustainable practices, social entrepreneurship and ability to recognize a business opportunity that fits their skill sets and recognize the critical importance of values and ethics when engaged in entrepreneurial activities. This course demonstrates the understanding of how to launch the individual's entrepreneurial career and to recognize the innate entrepreneurial potential within themselves.

UNIT-I

Engineering Economics: Definition and concept, Importance of economics for engineers, present value and future value, Wealth, Goods, Wants, Value and price, capital, money, utility of consumer and producer goods.

Costing: Introduction, Elements of cost, Prime cost, Overhead, Factory cost, Total cost, Selling price, Nature of cost, Types of cost.

Depreciation: Definition and concept, Causes of depreciation, Methods of calculating depreciation.

Economic analysis of investment and selection of alternatives: Introduction, Nature of selection problem, Nature of replacement problem, Replacement of items which deteriorate, Replacement of machines whose operating cost increase with time and the value of money also changes with time, methods used in selection of investment and replacement alternatives.

(14 hrs)

UNIT-II

Entrepreneurship: Entrepreneurship, Entrepreneurship Development, Characteristics and Qualities of an entrepreneur, some myths and realities about entrepreneurship, Functions of an Entrepreneur, Key Entrepreneurial skills, Creativity & Innovation, Entrepreneurial Opportunity Recognition Process, Business Ideas, Feasibility Studies, Business Plan

Small scale Industries: Introduction, Role and scope of small scale industries, concept of small scale and ancillary industrial undertakings, how to start a small scale industry, steps in launching own venture, various developmental agencies-their functions and role in industrial and entrepreneurship development, Infrastructure facilities available for entrepreneurship development in India. **(12 hrs)**

UNIT-III

Product Design: Introduction, Requirement of a good product design, Various controlling agencies involved -their role and formalities for getting clearance before starting individual venture. Concept Generation,

Marketing: The modern concept of marketing, Definitions, functions and principle of marketing, STPD, 4Ps, Marketing –Tools with real time approach. **(6 hrs)**

UNIT-IV

Start-Ups: Why a start-up, Types of Start-Ups, Characteristics of Start-Ups , Start-Up Ecosystem, Reasons for starting business, Concepts of TAM, SAM , MVP, GTM, PMF. AIDA model, Sales funnel, Team Building, Hiring. Knowledge about MCA policies regarding Start-Ups and role of various financial institutions, how to launch a company in India, Factors Entrepreneurs Consider while Launching a Start-up Raising Investments- Venture Capitalists, Angle Investors, Start-ups Best Practices, Some Examples of Startup Business Ideas and Successful Start-Ups, Techno-Economic feasibility project report, SWOT analysis.

(8 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text / Reference Books:

1. The practice of Entrepreneurship - By G. G. Meredikh, R.E. Nelson and P.A. Neck
2. Handbook of Entrepreneurship - Rao and Pareek
3. Entrepreneurship, 4e - Barringer,Pearson Publication
4. Entrepreneurship Development and Small Business Enterprises, - Charanthimath, Pearson Publication
5. Engineering Economics- Tarachand
6. Industrial Engineering and Management- Ravi Shankar
7. Industrial Engineering and Organization Management by S.K.Sharma and Sawita Sharma
8. Industrial Engineering and Management- O.P. Khanna

Course outcomes

CO 1: Ability to recognize a business opportunity that fits the individual skill-sets.
CO 2: Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career and find an attractive market that can be reached economically and create appropriate a business model.
CO 3: Apply effective written and oral communication skills to business situations.
CO 4: Analyze the global business environment, the local business environment anduse critical thinking skills in business situations and develop an ethical understanding and perspective to business situations

MECHANICAL ENGINEERING DEPARTMENT
PIPC415: RELIABILITY AND MAINTENANCE ENGINEERING

Pre-requisite: QCA

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

This course will be useful in developing student's skill related to current maintenance practices and advanced maintenance issues handling in small and heavy process industries. The course imparts the theoretical and analytical skill based knowledge about maintenance practices in different Industries/plants. Various reliability based maintenance models with their industrial application are also covered under this course.

UNIT- I

Introduction to Probability concepts, RAM aspects in maintenance, Failure Distribution-Reliability function, CDF and PDF, hazard rate function, Bath tub curve for industrial repairable system, conditional reliability concept in maintenance, Exponential, Weibull, normal and lognormal distributions based maintenance models. System reliability determination: Series – parallel system reliability, Type of redundancy, k out of n standby system, redundant standby systems, system structure functions, minimal cuts and minimal paths.

Markov analysis for system availability: load sharing system, stands by systems, degraded systems **(12 hrs)**

UNIT– II

Maintenance overview: Maintenance definition, objectives and importance of maintenance, functions of maintenance: basic functions and composite functions, primary and secondary functions.

Maintenance strategies: Definition of maintenance strategy, Classification of maintenance strategies, other maintenance strategies, advantages and disadvantages of maintenance strategies.

Total Productive Maintenance: TPM Definition, Principles, TPM VIS-A-VIS Terro-Technology, Pillars of TPM, TPM implementation in industry. **(10hrs)**

UNIT– III

Maintenance Planning and scheduling: Maintenance planning and scheduling types and techniques, short and long term planning.

Condition monitoring: Condition signals and monitoring, condition monitoring techniques: Performance monitoring, temperature monitoring, thermography, leakage monitoring, vibration monitoring, lubricant monitoring, ultrasound monitoring, corrosion monitoring, Motor current signature analysis (MCSA).

Maintenance Effectiveness, indices and audit: OEE, Equipment availability, maintenance effectiveness assessment, KPI, maintenance performance measuring indices.

(12hrs)

UNIT-IV

Application of RCA, FMEA and FMECA tools for industrial maintenance, Design of fuzzy MATLAB tool box based FMEA decision support system for maintenance action, Fault tree and PN diagram based availability analysis, Maintenance decision making models with industrial application. **(6 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Book/Reference

1. Kelly A., "Maintenance Planning and Control", Butterworth-Heinemann.Ltd, London.
2. Cliffton R. H.,"Principle of Planned Maintenance", McGraw Hill Inc. New York
3. Charles E. E., "An Introduction to Reliability and Maintainability Engineering", McGraw Hill Education,New York, 2017.
4. Dhillon B S, "Engineering Maintainability", Prentice Hall of India, New Delhi, 2000.
5. Wireman Terry, "Preventive Maintenance", Reston Publishing Company, Reston Virginia, 1998

Course Outcomes

CO1: Student will be able to learn various reliability concepts and its implementation in industry.

CO2: Students will be able to develop reliability based mathematical modeling for industrial system.

CO 3: Students will gain knowledge related to maintenance objective/functions and TPM.

CO 4: Students will be able to learn how to plan & schedule the maintenance job.

MECHANICAL ENGINEERING DEPARTMENT
PIPE416: PRODUCT DESIGN AND DEVELOPMENT

Prerequisite: MD

L	T	P	Credits	Total Contact Hours
3	-	-	3	40

Brief description about the course:

This course blends the perspectives of marketing, design, and manufacturing into a single approach to product development. As a result, students are provided with an appreciation for the realities of industrial practice and for the complex and essential roles played by the various members of product development teams. The course is intended to provide the following benefits:

UNIT-I

Introduction: Characteristics of Successful Product Development , Who Designs and Develops Products? ,Duration and Cost of Product Development , The Challenges of Product Development , The Product Development Process ,Concept Development: The Front-End Process , Generic Product Development Process

Opportunity Identification: What Is an Opportunity, Structure of Opportunity Identification and its process , Process to Generate , Sense , Screen and develop Opportunities.

Product Planning: Product Planning Process, Product Development Projects , Evaluation of Projects , Pre-Project Planning

Customer Needs Identification: Importance of t Needs identification, Process of Identifying Customer Needs , Art of Eliciting Customer Needs ,Needs Interpretation, Needs Hierarchy and relative Importance. **(10 hrs)**

UNIT-II

Product Specifications: Concept of Product specifications, steps to establish the Target specifications, Setting of Final Specifications , Technical and Cost Models

Concept Generation: Activity of Concept Generation , Methods of Concept Generation, Problem Decomposition Concept Classification Tree, Concept Combination Table, Managing the Exploration Process

Concept Selection: Importance of Concept Selection , Methods of Concept Selection, Concept Screening and Scoring, Combining and Improving Concepts.

Concept Testing: Purpose of the Concept Testing, Methods, formats and Analysis for Testing, Selection methods for Concepts. **(14 hrs)**

UNIT-III

Industrial Design: What Is Industrial Design? Assessing the Need for Industrial Design , Importance of Industrial Design to a Product, Parameters for Industrial Design, Impact of Industrial Design, Industrial Design Process and its Management ,Assessing the Quality of Industrial Design, Ergonomic / Aesthetic Needs

Design for Manufacturing & Assembly: Definition of DFM, estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment.

Design for Environment: What Is Design for Environment? , Design for Environment Process - Drivers, Goals, and Team, Application of DFE Guidelines to the Initial Product Design.

Design for Robustness: Concept of Robust Design, Design of Experiments , Robust Design Process , Identification of Control Factors, Noise Factors. **(12 hrs)**

UNIT-IV

Product Management: Concept of Product Management, Functions of a Product Manager, Building a Product and Problem Discovery, Launch of a product

(4 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. K.T. Ulrich and S.D. Eppinger, "Product design and development", Tata McGraw Hill
2. Chitale & Gupta, "Product Development", Tata McGraw Hill
3. Monks, J. G., "Operations Management", McGraw Hill, 1997.
4. George Dietor, A material and Processing approach, McGraw Hill

Course outcomes

CO1: Describe an engineering design and development process

CO2: Demonstrate individual skill using selected manufacturing techniques

CO2: Employ engineering, scientific, and mathematical principles to execute a design from concept to finished product

CO4: Work collaboratively on a team to successfully complete a design project and effectively communicate the results of projects and other assignments in a written and oral format

MECHANICAL ENGINEERING DEPARTMENT
PIPE417: MECHANICAL METALLURGY

Pre-requisite: Production Technology-II, Material Science

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course
Mechanical Metallurgy is a subject in production and industrial engineering that focuses on the mechanical behavior and properties of metals and alloys. It provides students with an understanding of the relationship between microstructure, processing, and mechanical properties, which is essential for designing and manufacturing high-quality metal components. It provides students with analytical skills for various metal forming processes.

UNIT - I

Stress-strain relationship for elastic behavior: Stress and Strain relationship, flow curves, effect of temperature on flow stress, theory of plasticity, state of stress in three dimensions, yield criteria for ductile materials, Tresca and Von-Mises yield loci, work hardening and anisotropy in yielding, effect of temperature on strain rate in metal working, friction and lubrication in cold and hot working. **(8 hrs)**

UNIT – II

Analysis of Forging process: Plane strain condition in forging, open-die and close-die forging, calculation of forging loads, forging defects.
Analysis of Rolling process: Rolling mills, hot rolling, cold rolling, forces and geometrical relationship in rolling, analysis of rolling loads, torque and power in rolling, defects on rolled products. **(12 hrs)**

UNIT - III

Analysis of wire drawing: Wire drawing, rod drawing, tube drawing and tube sinking, Analysis of wire drawing, frictionless wire drawing.
Extrusion: Forward and backward extrusion, hydrostatic extrusion, extrusion of tubes, metal flow in extrusion, extrusion analysis, upper-bound analysis, energy dissipation on a plane of discrete shear, frictionless plane strain extrusion of rectangular slab, plane strain extrusion of rectangular billet with friction. **(12 hrs)**

UNIT – IV

Sustainable and advanced topics in metal forming analysis with case studies, Analysis of sheet metal working: analysis of deep drawing, stretch forming and bending. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Metal Forming: W. Hosford and R. Caddell, (Cambridge University Press, 2007)
2. Mechanical Metallurgy – G.E. Dieter (McGraw-Hill, 1988)
3. Industrial Metal Working Processes: G. W. Rowe, CBS Publishers & Distributors (2005)
4. Fundamentals of Metal Forming Processes: B. L. Juneja (New Age International)
5. Manufacturing Processes for Engineering Materials: S. Kalpakjian and S. R. Schmid, Pearson Education

Course Outcomes

CO1: Students will understand and demonstrate the stress-strain relationship and flow curves for the metal working.

CO2: Students will evaluate and analyze the forging loads and identify the defects in forged products.

CO3: Students will evaluate and analyze the rolling forces, loads, torque and power along with identification of rolling defects in rolled products.

CO4: Students will evaluate and solve the problems in drawing, extrusion and sheet metal working using analytical skills.

MECHANICAL ENGINEERING DEPARTMENT

PIPE418: SIX SIGMA: CONCEPTS AND METHODOLOGY

Pre-requisite: Quality Control and Assurance

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Six Sigma is a best in class process improvement strategy that focuses on reducing process variation in business operations. It aims to achieve operational excellence by minimizing defects and waste in the system. This course can provide the general procedure and framework to understand and implement the six sigma in any organization.

UNIT-I

Quality concepts, evolution of continuous improvement, concept of six sigma, need for six sigma, process yield, statistical rationale of six sigma, belt system, teams, leadership in six sigma, resources for six sigma, roles and responsibilities of six sigma professionals.

(8 hrs)

UNIT-II

Six Sigma Strategy: Six sigma strategic planning, define measure analyze improve control (DMAIC), design for six sigma (DFSS), selection of six sigma toolset, enablers of six sigma, obstacles of six sigma.

(10 hrs)

UNIT-III

Six Sigma Project Implementation: Implementation framework, Define: project identification, project selection, problem definition, voice of customer, project critical to quality, improvement opportunity, process mapping, Measure: six sigma metrics, critical process assessment, measure metrics, Analyze: source of variations, analyzing root causes, Improve: six sigma improvement, implementation planning, innovate solution, selecting a solution, piloting the solution, improvement evaluation, lean process improvement, Control: need of control and monitoring in six sigma project, out of control action plan.

(14 hrs)

UNIT-IV

Six Sigma for Operational Excellence: combining lean and six sigma methodologies, sustainable six sigma, integration with industry 4.0, tangible gains of six sigma, impact on organization

sustainability, six sigma case studies: manufacturing sector, healthcare, higher education, supply chain management. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. An introduction to six sigma and process improvement by james r. evans & william m. lindsay, cengage learning, ISBN: 1133604587
2. Six sigma handbook by thomas pyzdek, paul a. keller, mc graw hill, 5th edition ISBN: 9781260121827
3. The certified six sigma black belt handbook, by t. m. kubiak, donald w. benbow, third edition (2016), ISBN: 0873899415
4. Six sigma for business excellence: approach tools and applications by hemant urdhwareshe, 2011, pearson

Course Outcomes

CO 1: Understand the basics of six sigma and role of teams in six sigma execution

CO 2: Interpret the six sigma implementation strategy for manufacturing and service sector

CO 3: Apply six sigma DMAIC process to reduce process variations

CO 4: Relate the sustainable and smart process improvement practices with conventional strategies

MECHANICAL ENGINEERING DEPARTMENT
PIPE419: TOOL ENGINEERING

Pre-requisite: Production Technology-III

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course:
Tool Engineering is a subject in production and industrial engineering that focuses on the design, development, and application of tools, jigs, fixtures, and cutting tools used in manufacturing processes. It provides students with the knowledge and skills necessary to design, select, and optimize tools and fixtures for efficient and precise production operations

UNIT-I

Cutting Tool Design: basic concepts of single and multi-point tool geometry and tool angles, design of single point cutting tools, design of multi-point cutting tools for milling, drilling, reaming, and broaching operations, design of form tools. **(8 hrs)**

UNIT-II

Jigs and Fixtures: Fundamentals, Difference between jig and fixture, Principles of location and clamping, locating methods and devices, clamping methods and clamping devices. Calculation of clamping force, Jig bushes, Types of jigs and Milling fixtures: Turning fixtures, Grinding fixtures, Boring and broaching fixtures, assembly and welding fixtures. Hydraulic and pneumatic clamp actuation, indexing devices, Different Materials for jigs and fixtures. Economics of Jigs and Fixtures, drawing and design of jigs and fixtures for given components. (**12 hrs)**

UNIT-III

Sheet metal die design: types of dies; Progressive, compound and combination, die construction: screws and dowels, die block, Punch design: Plain punches, pedestal punches, punches mounted in punch plates, perforator type punches, Quill punches, back-up plate, slug ejection, Pilots, stripper and stock guide: channel and spring stripper, die stops: solid stop, pin stop, latch stop, pivoted auto stop, stock strip layout, component design for blanking. Forging die design Parting plane, draft, fillet and corner radii, shrinkage allowance, die wear allowance, finish allowance, cavities, drop forging die design: flash, stock, fullering impression, edging impression, blocking impression, finishing impression, location of impressions, die inserts, upset forging die design.
(12 hrs)

UNIT-IV

Sustainable practices in Tool engineering, emerging trends in cutting tools materials and manufacturing approaches, case studies of die design for sheet metal and forging operations in potential industries like automobile. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Rodin, R., "Design and Production of Metal-Cutting Tools",Mir Publishers, 1968
2. Arshinov, V., Alekseev, G., and Weinstein, N., "Metal Cutting Theory and Cutting Tool Design", Mir Publishers, 1976
3. Bhattacharyya, A., and Ham, I., "Design of Cutting Tools", ASTME 1969
4. Hoffman, E.G., "Jigs and Fixture Design", Thomson Delmar Learning 2003
5. Grant Hiram E, "Jigs & Fixtures", Tata McGraw Hill,1994.
6. Curtis Mark A, "Tool Design for Manufacturing", John Wiley & Sons,1996.
7. Donaldson Cyril, "Tool Design", Tata McGraw Hill 1997.
8. Sharma P C, " Production Engineering", S Chand & Company,1997.
9. Joshi, P.H., Jigs and Fixtures, TMH.
10. Hinman, Press Working of Metals, McGraw-Hill.
13. P.N. Rao, Manufacturing Technology, TMH
14. Pandey and Singh, Production Engineering Sciences
15. ASTM E: Fundamentals of Tool Design, Prentice-Hall
16. S.A.J. Parsons, Production tooling equipment, Macmillan, London
17. Eary, D.P. and Johnson, G.E., Process Engineering, Prentice-Hall, 1962.

Course Outcomes

CO1: Students will design different types of single point, multipoint tool and form tools with appropriate tool geometry.

CO2: Students will demonstrate the design of jigs & fixtures and clamping devices for given requirements based on understanding of the fundamentals.

CO3: Students will understand the various sheet metal operations and design of sheet metal dies with stock strip layout analysis.

CO4: Students will analyze the allowances and design the forging dies for given components.

MECHANICAL ENGINEERING DEPARTMENT
PIPE421 ADVANCED MATERIALS

Pre-requisite: Material Science

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course:

Introduces advanced materials for engineers, emphasizing the production/structure/ property/function relation and application of a number of advanced materials. This subject is important to develop a comprehensive understanding of advanced materials, including their classification, properties and applications in various engineering domains. Primarily, it is intended to demonstrate the importance of advanced materialsn the present day scenario. It is also focused to understand the concept of applied mechanics which enables in understanding the behavior of advanced materials under different loading and environmental conditions.

UNIT-I

Introduction to Advanced Materials: History, definition and classification, Importance and applications, Emerging trends and challenges, Bulk metallic glass (BMG), glassy and amorphous materials: Definition and characteristics of Bulk Metallic Glass, Amorphous versus crystalline materials, Structure and Properties of Bulk Metallic Glass, Processing and Fabrication of Bulk Metallic Glass, Rapid solidification techniques: melt spinning, splat quenching, Thermoplastic forming of BMG Bulk processing methods: powder metallurgy, hot pressing, injection molding Joining and welding of BMG, Mechanical Behavior of Bulk Metallic Glass, shear banding, strain hardening, Glassy and Amorphous Materials, metallic glasses, oxide glasses, organic glasses, Structure and Properties of Glassy and Amorphous Materials, Bulk metallic glass Processing Techniques. **(12 hrs)**

UNIT-II

Shape memory alloys (SMAs): Introduction, nickel-titanium (NiTi) alloys, copper-based alloys, iron-based alloys, Crystal Structure and Phase Transformations, superelasticity and shape memory effect, Stress-strain behavior and deformation mechanisms in SMAs, Pseudoelasticity and recoverable strain, Effect of temperature, strain rate, and loading conditions on SMA behavior, Shape Memory Alloy Processing Techniques.

(10 hrs)

UNIT-III

High temperature materials and superalloys: Introduction, metallic materials/alloys, solid solution strengthening, precipitation strengthening, dispersion strengthening, ceramic materials, phase control, defect tolerance and thermal shock resistance, composites matrix, carbon-carbon matrix,

titanium matrix, ceramics matrix, mechanical behavior of high temperature materials. Application, case study

Superalloys: Introduction, Nickel-based Superalloys, cobalt based Superalloys, Iron-based superalloy, Larson-miller approach, Alloy design, strengthening mechanism, Microstructural properties, superalloy applications. **(8 hrs)**

UNIT-IV

Nanomaterials and biomaterials: Definition and characteristics of nanomaterials, Classification of nanomaterials, Size-dependent properties at the nanoscale, Top-down and bottom-up approaches, Nanomaterial Synthesis Techniques, Properties and Behavior of Nanomaterials, Nanomaterials for Energy Applications

Biomaterials: Definition and characteristics of biomaterials, Biocompatibility and host response to biomaterials, Classification of biomaterials based on composition and functions.

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. William F. Smith, Javad Hashemi; Foundations of Materials Science and Engineering, McGraw Hill.
2. Thomas H. Courtney; Mechanical Behavior of Materials, McGraw Hill Education India.
3. William D. Callister Jr., David G. Rethwisch; Materials Science and Engineering: An Introduction, WILEY Publication, USA.
4. Michael F. Ashby, Hugh Shercliff, David Cebon; Materials: Engineering, Science, Processing and Design, ELSEVIER.
5. George Dieter; Mechanical Metallurgy, McGraw Hill.

Course Outcomes

CO1: History and evolution of Advance materials and recent developments in this field.

CO1: Basic concepts and applications of applied mechanics of advanced materials.

CO1: Elemental knowledge about processing characterization and mechanical behavior.

CO1: Gain knowledge about the processing techniques used for Advanced Materials, such as synthesis, fabrication and manufacturing processes.

MECHANICAL ENGINEERING DEPARTMENT
PIPE422: HYBRID MACHINING METHODS

Pre-requisite: Production Technology-II

L	T	P	Credits	Total contact hours
03	--	--	03	40

Brief description about the course:

This course provides students with an understanding of hybrid machining technology and skills relating to the implementation of these technologies in the modern industry within both global and local contexts. Topics include basics of hybrid machining processes, abrasive assisted machining principles, magnetic assisted machining solutions, etc.

UNIT-I

Introduction: Types of Hybrid machining processes; Evolution, need, and classification of Hybrid machining processes (HMP's).

Abrasion assisted HMPs; AWEDM: abrasive wire cut electrical discharge machining; EDAG: electrical discharge abrasive grinding; ECAG: electrochemical abrasive grinding; AECF: abrasive electrochemical finishing; AEDF: abrasive electrical discharge finishing; AECH: abrasive electrochemical honing. Process principle and elements; Tool design; Mechanism of material removal, several input process variables and parametric analysis; Operational characteristics; Limitations.

(10 hrs)

UNIT-II

Hybrid electrical-chemical processes; ECDM: electrochemical discharge machining; ECAM: electrochemical arc machining. EDDG: Electric Discharge Diamond Grinding. Process principle and elements, Operational characteristics; Limitations.

Laser assisted HMPs; LAT: laser-assisted turning; LAG: laser-assisted grinding; LAEDM: laser-assisted electrical discharge machining; LAECM: laser-assisted electrochemical machining; LAE: Laser assisted etching. Mechanism of material removal, process parameters; Shape and material applications **(10 hrs)**

UNIT-III

Ultrasonic assisted HMPs RUSM: Rotary ultrasonic machining; RUFM: Rotary ultrasonic face milling; UAT: ultrasonic assisted turning; UAD: ultrasonic-assisted drilling; UAG: Ultrasonic vibration assisted grinding; UAEDM: ultrasonic-assisted EDM, UAECM: ultrasonic-assisted

ECM. Tool design; Mechanism of material removal, several input process variables and parametric analysis; Shape and material applications. **(10 hrs)**

UNIT-IV

Magnetic force assisted HMPs MFEDM: magnetic force–assisted EDM; MFECM: magnetic field–assisted ECM; MAF: magnetic abrasive finishing. Process principle and elements; Tool design; Mechanism of material removal.

Misc. Topics: Process selection and process planning for several newest and novel HMPs. Conceptuals for the in-house development of hybrid machining methods with some real-life case studies

(10 hrs)

NOTE:

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Text/Reference Books

13. Sharma P C, "Production Engineering", S Chand & Company,1997.
14. Heine, R.W., Loper, C.R. and Rosenhal, P.C., "Principles of Metal Casting", TMH.
15. P.N. Rao, "Manufacturing Technology", TMH
16. Pandey and Singh, "Production Engineering Sciences"
17. Ghosh & Mallik, Manufacturing Science, Affiliated East West Press.
18. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials and Processes in Manufacturing", Prentice-Hall of India.
19. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
20. Groover, M.P., "Fundamentals of Modern Manufacturing", JohnWiley & Sons.
21. Mix, Paul E, "Introduction to Nondestructive Testing: A Training Guide", John Wiley and Sons Ltd, 1999.
22. Henrique L M, "Non Destructive Testing and Evaluation for Manufacturing and Construction", Hemisphere Publishers, New York, 2001.
23. Kuo, S., "Welding Metallurgy", John Wiley & Sons 2003
24. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill 1988.

Course Outcomes

CO1: Explain the applications of powder metallurgy in manufacturing sector.

CO2: Classify the various gear manufacturing processes along with their finishing processes.

CO3: Fabricate the composite materials and their effective processing.

CO4: Test the weld quality and design the various elements of casting.

MECHANICAL ENGINEERING DEPARTMENT
PIPE423: MICRO AND NANO FABRICATION METHODS

Pre-requisite: PT-II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description:
This course covers the various methods of micro and nanofabrication methods that are used for the development of precise and miniaturized components for industries related to electronics, medical, automotive, etc. The course will provide detailed knowledge about concepts of microsystem devices and various microfabrication methods and advanced machining methods for micro-manufacturing. The students will gain knowledge of nanoscience and nanofabrication methods. The students will also learn about micromachining, nano-texturing, and Laser material removal processes for difficult-to-cut materials.

UNIT-I

Introduction to Microsystems and Microfabrication Methods: Microsystem devices, Microsystem Applications, Clean rooms, Substrate and Cleaning, Microfabrication methods: Silicon Layer Processes; lithography, oxidation, Chemical vapor deposition, Physical vapor deposition, Electroplating, Electroless plating, Diffusion & implantation, Etching and its types.

(10 hrs)

UNIT-II

Advanced Microfabrication Methods: LIGA Process, Soft lithography, photochemical machining, Electro discharge machining, Electron-beam machining, LASER beam machining, Rapid Prototyping technologies for Microfabrication: Electrochemical Fabrication (EFAB), Micro-stereolithography, Photofabrication. **(10 hrs)**

UNIT-III

Nanotechnology and Nanofabrication Methods: Nanoscience; sizes and measuring instruments, Nanotechnology products; categories and their applications, Carbon nanostructures; methods of production, Nanofabrication methods; Extreme UV lithography, Electron beam & Xray lithography, Scanning Probes Techniques; SPM, AFM, Dip-pen nanolithography (DPN), Self-Assembly **(12 hrs)**

UNIT-IV

Nanomachining and Nanotexturing Methods: Diamond Microchiseling of miniaturized retroreflectors, Microscale cutting; micro-end milling, cutting process, micro-dimple milling, Nano-grooving by multi-tip diamond tool, Elliptical vibration cutting, Micro/Nano-texturing by Ultrasonic Assisted Grinding, Laser Ablation. Case study: study of the fabrication of MEMS and NEMS **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text/Reference Books:

1. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
2. Groover, M.P., "Fundamentals of Modern Manufacturing", John Wiley & Sons.
3. Hans H. Gatzen, "Micro and Nano Fabrication: Tools & Processes", Springer.
4. Eiichi Kondoh, "Micro-and Nanofabrication for Beginners", Jenny Stanford Publishing Pte. Ltd.
5. Jiwang Yan, "Micro and Nano Fabrication Technology", Springer

Course outcomes

CO1: Knowledge of microsystem devices and their microfabrication methods.

CO1: Knowledge of advanced machining methods for micro-manufacturing.

CO1: Knowledge of nanoscience and nanofabrication methods for making nanostructures.

CO1: Knowledge of micromachining, nano-texturing, and Laser material removal processes for difficult-to-cut materials.

MECHANICAL ENGINEERING DEPARTMENT
PIOE424: EXPERIMENTAL DESIGN TECHNIQUES

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Experimental Design Techniques cover a wide range of tools, methods and techniques of statistics for investigation and enhancement /optimization of product design, Process performance, Process Quality. This course is targeted on providing insight into the different aspects of DOE like introduction to basic statistical concepts and tools, choice of experimental design, methodology for optimization of responses of interest, drawing inferences from the statistical analysis etc. The students will learn to apply the concepts of DOE for experimental research on the given problem.

UNIT-I

Introduction: Objectives for experimental design, Basic design concepts: Randomization, Blocking and Replication, Steps in designing the experiments, Types of experimental designs, Sampling distributions.

Statistical Inference: Generation of hypotheses, Testing of hypotheses, OC curve, Tests on means, Tests on variances, Assessing normality, Model adequacy tests, Orthogonal Contrasts, ANOVA rationale, Confidence limits on means, Components of variance. **(9 hrs)**

UNIT-II

Completely Randomized Design: Model for a completely randomized design with a single factor, ANOVA for a completely randomized design, Randomized block design, Incomplete block design, Latin square design, One way ANOVA, Two way ANOVA, Balanced ANOVA.

Full Factorial Design: Nature of factorial designs, Estimation of Interaction effects, Main effect estimates, The 2^3 design, Built-in-replication, 3^3 design, Confounding systems, ANOVA for full factorial design. **(11 hrs)**

UNIT-III

Robust Designs: DOE and Taguchi approach. Experimental Design using orthogonal arrays, Experimental design with two and three level factors, ANOVA for Taguchi method, Signal-to-Noise Ratio, Case study on application of robust design. **(9 hrs)**

UNIT-IV

Response Surface Methodology: Introduction to response surface, building empirical models, First order and second order models, Approximating the response function, Estimation of the parameters in linear regression models, hypothesis testing and ANOVA for multiple regression, Testing Lack of fit, Fitting second order model to data, Two level factorial designs, addition of center points, two level fractional factorial designs. **(11 hrs)**

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Text Books / Reference

1. Design and Analysis of Experiments by D.C. Montegomery, John Wiley and Sons, 2003/04, ISBN-978-81-265-1048-1
2. Design of Experiments using the Taguchi Approach by Ranjit K Roy, John Wiley, NY, 2006.
3. Fundamental Concepts in Design of Experiments, Charles R. Hicks, Oxford University Press, NY, 1999.
4. Response Surface Methodology: Product and Process Optimization using Designed Experiments, Raymond H. Myers, D.C. Montegomery, Wiley, 2009.

Course Outcomes

CO1: Understand the fundamentals of experimental design.
CO2: Identify the DOE technique to be applied for the given experimental problem
CO3: Apply the DOE techniques to optimize the product/process parameters.
CO4: Evaluate the model adequacy; interpret the findings of the DOE study and to draw the appropriate inferences at the selected level of confidence.

MECHANICAL ENGINEERING DEPARTMENT
PIOE425: SIX SIGMA CONCEPTS AND METHODOLOGY

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Six Sigma is a best in class process improvement strategy that focuses on reducing process variation in business operations. It aims to achieve operational excellence by minimizing defects and waste in the system. This course can provide the general procedure and framework to understand and implement the six sigma in any organization.

UNIT-I

Quality concepts, evolution of continuous improvement, concept of six sigma, need for six sigma, process yield, statistical rationale of six sigma, belt system, teams, leadership in six sigma, resources for Six Sigma, roles and responsibilities of six sigma professionals. **(8 hrs)**

UNIT-II

Six Sigma Strategy: Six sigma strategic planning, define measure analyze improve control (DMAIC), design for six sigma (DFSS), selection of six sigma toolset, enablers of six sigma, obstacles of six sigma. **(10 hrs)**

UNIT-III

Six Sigma Project Implementation: Implementation framework, Define: project identification, project selection, problem definition, voice of customer, project critical to quality, improvement opportunity, process mapping, Measure: six sigma metrics, critical process assessment, measure metrics, Analyze: source of variations, analyzing root causes, Improve: six sigma improvement, implementation planning, innovate solution, selecting a solution, piloting the solution, improvement evaluation, lean process improvement, Control: need of control and monitoring in six sigma project, out of control action plan. **(14 hrs)**

UNIT-IV

Six Sigma for Operational Excellence: combining lean and six sigma methodologies, sustainable six sigma, integration with industry 4.0, tangible gains of six sigma, impact on organization sustainability, six sigma case studies: manufacturing sector, healthcare, higher education, supply chain management. **(8 hrs)**

NOTE:

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Text Books / Reference

5. An introduction to six sigma and process improvement by james r. evans & william m. lindsay, cengage learning
6. Six sigma handbook by thomas pyzdek, paul a. keller, mc graw hill
7. Six sigma the breakthrough management strategy revolutionizing the world's top corporations
8. Six sigma for business excellence: approach tools and applications by hemant urdhwareshe, pearson

Course Outcomes

CO 1: Understand the basics of six sigma and role of teams in six sigma execution
CO 2: Interpret the six sigma implementation strategy for manufacturing and service sector
CO 3: Apply six sigma DMAIC process to reduce process variations
CO 4: Relate the sustainable and smart process improvement practices with conventional strategies

MECHANICAL ENGINEERING DEPARTMENT
PIOE426: PROJECT MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course suggests ways of improving project appraisal and capital budgeting practices and also describes and evaluates business practices in various areas. Further, it discusses key principles and techniques for evaluating capital expenditure proposals, as well as strategic, qualitative and organizational considerations impacting capital budgeting decisions

UNIT-I

Characteristics of a project types of projects, Project Management Body of Knowledge(PMBOK), role of project manager and his qualities, project organization and benefits, idea generation, needs ofsociety, project lifecycle, project charter, project sponsor.

PROJECT PLANNING: Customer needs, stake holder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude. **(10hrs)**

UNIT-II

STRUCTURE: Project selection methods, breakeven analysis, DCF methods, project implementation, estimation, cost, price, value, scheduling, bar charts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management, decision trees. **(8hrs)**

UNIT-III

Vendor selection methods, resource planning and allocation, availability and constraints of resources, Project scope, project cost and quality, project reports, project audits, Project evaluation, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis. **(10hrs)**

UNIT-IV

Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health, human and environment all factors, project finance.

A project management case study: that showcases the challenges that the organization faced, the solutions adopted, and the final results. **(12hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation, and Review", TATA McGraw Hill, New Delhi,2010.
2. K. K. Chitkara," Construction Project Management Hardcover" TATA McGraw Hill, New Delhi,2010.
3. Harold Kerzner, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", 13th Edition, Wiley, NewYork.
4. R.Panneerselvam, "Project Management",PHI, India
5. Nagarajan, K, "Project Management", New Age International Pvt Ltd, India.

Course Outcomes

CO 1 Discuss complete structure of project management and analyze the scope of project planning.

CO 2 Identify different project selection methods.

CO 3 Explain the importance of procurement and its techniques.

CO 4 Define the guidelines required for project control and its controlling techniques.

MECHANICAL ENGINEERING DEPARTMENT
PIOE427: INDUSTRIAL ENGINEERING AND MANAGEMENT

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Industrial Engineering Management course focuses on optimizing complex systems and processes in various industries. It combines engineering principles with business management techniques to improve overall productivity and performance. Industrial engineers analyze and evaluate various factors, and manage business/industrial systems involving people, materials, methods, and machines.

UNIT-I

Definition, role, and scope of industrial engineering, industrial engineering approach and techniques, principles of organization, elements of organization, types of organization.

Plant layout, site selection, types of plant layout, factors affecting layout, plant building, flexibility and expansion. **(8 hrs)**

UNIT-II

Materials Management: Introduction, inventory, inventory costs, inventory cost relationship, inventory control models, ABC analysis MRP, elements of MRP.
Work study: Method study, method study techniques, work measurement techniques, time study, observed time, basic time, normal time, allowances, standard time. **(10 hrs)**

UNIT III

Sales Forecasting Introduction, objectives of sales forecasting, types of forecasting, methods of sales forecasting; collective opinion method, Delphi technique, moving average method, time series analysis, simple exponential smoothing, measurement of forecasting errors.

Quality Management: Quality, dimensions of quality, quality control, basic QC tools, introduction to statistical quality control, quality assurance six-sigma introduction. **(12 hrs)**

UNIT-IV

Basics of project management, network analysis, Critical path method, Program evaluation and review technique, Comparison between CPM and PERT

Advancement in Industrial Management: Industry 4.0, lean management, sustainable industrial practices, case studies pertains to advanced industrial practices **(10 hrs)**

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Text Books / Reference

1. Production and operations management by S.N.Chary Publication Tata Mc Graw Hill (TMH)
2. Industrial Engineering and Organization Management by S.K. Sharma & Savita Sharma Publication Kataria & sons
3. Industrial Engineering and Production management by Martland T Telsang Publication S. chand
4. Modern Production Management by Elwood S. Buffo Rakesh K. Sarin Publication John Wiley & Sons
5. Jocobs, C.A., "Production and Operations Management", Tata McGraw Hill
6. Handbook of Industrial Engineering: Technology and Operations Management, by Gavriel Salvendy, publication John Wiley & Sons
7. Mitra, A., "Fundamentals of Quality Control and Improvement", John Wiley & Sons, Inc.

Course Outcomes

CO1: Understand industrial engineering concepts to optimize the industrial resources
CO2: Use plant layout concepts to develop and expand the industrial layouts.
CO3: Apply forecasting and materials management for smooth functioning of industry on shop floors
CO4: Analyze the quality of product and services in industrial scenario with concept of quality management

MECHANICAL ENGINEERING DEPARTMENT
PIOE428: TOTAL QUALITY MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Total Quality Management is a business improvement strategy to management that focuses on continuous improvement, customer satisfaction, and the involvement of all employees in the organization. This course provides a holistic and comprehensive management philosophy that aims to enhance the quality of products, services, and processes within an organization.

Unit-I

Products and services, quality and productivity, dimensions of quality: manufacturing and service, continuous improvement**,** quality management practices, need of TQM, concept of TQM, elements of TQM, pillars of TQM, companywide organization for quality management, quality awards.

(8 hrs)

Unit-II

TQM Leadership and Techniques: Motivation and involvement for total quality, strategic planning, corporate culture, total employee involvement, total commitment, role of information in total quality, soft and hard practices of TQM, quality circle, seven QC tools, failure mode effect analysis, gemba kaizen, 6S, benchmarking, zero defects, PDCA cycle. **(12 hrs)**

Unit-III

TQM Framework and Systems: Success factors and obstacles in TQM implementation, Implementing TQM, TQM framework, quality management systems; ISO 9000 Series of standards, ISO 9001 structure, ISO 14000 series standards, concepts of ISO 14001, requirements and benefits of ISO 14001. **(12 hrs)**

Unit-IV

TQM Case and Sustainable Practices: Sustainable TQM, TQM 4.0, lean-TQM, total productive maintenance, TQM case studies in manufacturing and service sector. **(8 hrs)**

NOTE:

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Text Books / Reference

1. Besterfield, D.H, Michna, C.B, Besterfield, G. H and Sacre, M.B, "Total Quality Management" Pearson Education Asia.
2. Mukherjee, P. N., "Total Quality Management" Prentice Hall of India.
3. Rajaram, S., "Total Quality Management" Biztantra.
4. Ramasamy, S. "Total Quality Management" Mc Graw Hill Education.

Course Outcomes

CO 1: Understand the fundamentals of quality management practices.
CO 2: Discuss the need of customer expectations, employee involvement and supplier partnership.
CO 3: Apply the TQM tools and techniques to improve the product and process quality.
CO 4: Describe quality Management system standards and certification process.

MECHANICAL ENGINEERING DEPARTMENT
PIOE429: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

To understand concept of Supply chain management and apply this knowledge to understand the working of corporate world.

UNIT-I

Understanding the Supply Chain, Performance, Drivers and Obstacles, Objectives of supply chain, Stages of supply chain, Supply chain process cycles, Push/pull view of supply chain processes, Importance of supply chain flows, Examples of supply chain, Strategic decisions in supply chain management. Supply Chain Performance, Supply chain strategies, achieving strategic fit, Product life cycle, Supply Chain drivers and Obstacles, four drivers of supply chain – inventory, transportation, facilities, and information, Obstacles to achieve strategic fit. **(9 hrs)**

UNIT-II

Planning Demand and Supply in a Supply Chain, Role of forecasting in a supply chain, Forecasting methods in a supply chain, Basic approach to demand forecasting, Aggregate planning resources. Managing economies of scale in a supply chain, Role of cycle inventory in a supply chain.

Transportation and Coordination in a Supply Chain, Facilities affecting transportation decisions, Transport selection, Modes of transportation and their performance characteristics, Trade-offs in transportation decision, Making transportation decisions in practice, Models for transportation and distribution, Third party logistics (3PL). **(12 hrs)**

UNIT-III

Coordination in a Supply chain, Lack of supply chain coordination and the Bullwhip effect, Effect of lack of coordination on performance, Obstacles to coordination, Achieving coordination in practice.

Source Management and IT in Supply Chain, Inventory management in supply chain, Information technology in supply chain, Typical IT solution, Reverse supply chain, Reverse supply chain Vs. Forward supply chain. **(9 hrs)**

UNIT-IV

Advanced topics in SCM: Green, Lean, Sustainable, Global and Agile supply chain Management, Quality in Supply Chain. Integration and Collaborative Supply Chain, Circular Supply Chain Management.

Cases in Supply Chain: Case Studies such as Newspaper, Mumbai Tiffanwala, Disaster Management, Organic Food, Fast Food, Hostel Mess etc. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Book / Reference Books

1. Christopher Martin, "*Logistics and Supply Chain Management*", Pearson Education Asia.
2. Chopra Sunil and Meindl Peter, "*Supply Chain Management – Strategy, planning and operation's",* Pearson Education, Asia.
3. Kapoor K K, KansalPurva, "*Marketing logistics: A Supply Chain Approach*", Pearson Education Asia.
4. Mohanty, R.P and Deshmukh, S.G., "*Supply Chain Management*", Pearson Education Asia.
5. Fawcett, S. E., Ellram, L. M and Ogden, J. A., "Supply Chain Management" Pearson Education Asia.
6. Dixit Garg, Sunil Luthra and Sachin Mangla., "Supply Chain and Logistics Management". New Age International Publishers

Course Outcomes

CO1: Understand the decision phases and apply competitive & supply chain strategies.

CO2: Understand drivers of supply chain performance.

CO3: Analyze factors influencing network design and forecasting in a supply chain.

CO4: Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

SCHEME OF EXAMINATION
B. Tech. (Mechanical Engineering) 2nd Semester

CODE	COURSE	L	T	P	Credits
HSIC101	Communication Skills in English	2	0	2	3
	OR				
HSIC103	Financial Education	3	0	0	3
MAIC102	Integral Calculus and Difference Equations	3	0	0	3
PHIC102	Advanced Engineering Physics	2	0	2	3
MEIC102	Engineering Practice(For CE, EE, ME & PIE)	1	0	3	2
CHIC102	Chemistry	2	0	2	3
HSNC101-105, MANC101	Any one subject from Group-I	2	0	0	2
PIPC101	Manufacturing Processes	4	0	4	4
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				20

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

GROUP - I	
CODE	**COURSE**
HSNC 101	Human Values and Social Responsibility
HSNC 102	Sanskrit Language Skills
HSNC 103	Hindi Language Skills
HSNC 104	Telugu Language Skills
HSNC 105	Constitution of India
MANC 101	Vedic Mathematics

SCHEME OF EXAMINATION
B.Tech. (PIE) 3rd Semester

CODE	COURSE	L	T	P	Credits
PIPC201	Thermodynamics	3	0	0	3
PIPC202	Fluid Mechanics and Machines	3	0	0	3
PIPC203	Facilities Design	3	0	0	3
PIPC204	Theory of Machines	3	0	0	3
IC*	Machine learning and Data Analytics	3	0	2	4
PIPC205	Production Technology-I	3	0	0	3
PIPC206	Production Technology-I (P)	0	0	2	1
PIPC207	Fluid Mechanics and Machines (P)	0	0	2	1
PIPC208	Theory of Machines (P)	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				22

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

SCHEME OF EXAMINATION
B. Tech. (PIE) 4th Semester

CODE	COURSE	L	T	P	Credits
PIPC209	Production Technology-II	3	0	0	3
PIPC210	Operations Research	3	0	0	3
PIPC211	Strength of Materials	3	0	0	3
PIPC212	Heat Transfer	3	0	0	3
PIPC213**	Machine Drawing	1	0	5	3
PIPC214	Value Engineering	3	0	0	3
PIPC215	Materials Science	3	0	0	3
PIPC216	Production Technology-II (P)	0	0	2	1
PIPC217	Strength of Materials (P)	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				23

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

*****Not to be counted towards integrated course.***

B.Tech (PIE) 5th Semester

CODE	COURSE	L	T	P	Credits
PIPC301	Production Technology – III	3	0	0	3
PIPC302	Production Planning & Control	3	0	0	3
PIPC303	Machine Design**	2	0	4	4
PIPE***	Any one subject from Group III	3	0	0	3
PIPE***	Any one subject from Group IV	3	0	0	3
OE*		3	0	0	3
PIIC314	Internship/Training/Project Viva-Voce (4-6 weeks duration after 4th semester examination)				2
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				21

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

*****Not to be counted towards integrated course.***

PROGRAM ELECTIVES

GROUP - III		GROUP - IV	
CODE	COURSE	CODE	COURSE
PIPE304	Refrigeration and Air Conditioning	PIPE309	Computer Aided Design
PIPE305	Design of Heat Exchangers	PIPE310	Industrial Automation and Robotics
PIPE306	Renewable Energy Systems	PIPE311	Industrial Tribology
PIPE307	IC Engines and Gas Turbine	PIPE312	Mechatronics
PIPE308	Computational fluid dynamics	PIPE313	Vibrations and Noise

B.Tech (PIE) 6th Semester

CODE	COURSE	L	T	P	Credits
PIPC315	Quality Control and Assurance	3	0	0	3
PIPC316	Work Study and Ergonomics	3	0	0	3
PIPC317	Experimental Design	3	0	0	3
PIPE***	Any one subject from Group V	3	0	0	3
PIPE***	Any one subject from Group VI	3	0	0	3
OE*		3	0	0	3
PIPC328	Work Study and Ergonomics (P)	0	0	2	1
PIPC329	Technical Discussions	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				24

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

PROGRAM ELECTIVES

GROUP - V		GROUP - VI	
CODE	COURSE	CODE	COURSE
PIPE318	Computer Integrated Manufacturing	PIPE323	Automobile Engineering
PIPE319	Sustainable Manufacturing	PIPE324	Finite Element Method
PIPE320	Materials Management	PIPE325	Thermal Power Engineering
PIPE321	Numerical Methods in Manufacturing	PIPE326	Solar Energy
PIPE322	Rapid Prototyping	PIPE327	Power Plant Engineering

B. Tech. (PIE) 7th Semester

CODE	COURSE	L	T	P	Credits
PIPC401	Logistics & Supply Chain Management	3	0	0	3
PIPC402	Non Conventional Machining	3	0	0	3
PIPC403	Metrology & Measurements	3	0	0	3
PIPE***	Any one subject from Group VII	3	0	0	3
PIPE***	Any one subject from Group VIII	3	0	0	3
OE*		3	0	0	3
PIPC414	Metrology & Measurements (P)	0	0	2	1
PIIC415	Internship/Training/Project Viva-Voce (4-6 weeks duration after 6th semester examination)				2
	Total Credits				21

PROGRAM ELECTIVES

GROUP - VII		GROUP - VIII	
CODE	COURSE	CODE	COURSE
PIPE404	Computer Aided Process Planning	PIPE409	Project I
PIPE405	Advanced Welding Technology	PIPE410	Lean Manufacturing
PIPE406	Total Quality Management	PIPE411	Additive Manufacturing
PIPE407	Project Management	PIPE412	Artificial Neural Network
PIPE408	Nuclear Engineering	PIPE413	Introduction to MATLAB Programming

B. Tech. (PIE) 8th Semester

CODE	COURSE	L	T	P	Credits
PIIC414	Entrepreneurship and Start-ups	3	0	0	3
PIPC415	Reliability and Maintenance Engineering	3	0	0	3
PIPE***	Any one subject from Group IX	3	0	0	3
PIPE***	Any one subject from Group X	3	0	0	3
OE*		3	0	0	3
	Total Credits				15

PROGRAM ELECTIVES

GROUP – IX		GROUP - X	
CODE	COURSE	CODE	COURSE
PIPE416	Product Design and Development	PIPE420	Project II
PIPE417	Mechanical Metallurgy	PIPE421	Advanced Materials
PIPE418	Six Sigma: Concepts and Methodology	PIPE422	Hybrid Machining Methods
PIPE419	Tool Engineering	PIPE423	Micro and Nano Fabrication Methods

List of Open Electives to be offered by Production Engineering Department

Odd Semester		Even Semester	
CODE	**COURSE**	**CODE**	**COURSE**
PIOE424	**Experimental Design**	**PIOE427**	**Industrial Engineering and Management**
PIOE425	**Six Sigma: Concepts and Methodology**	**PIOE428**	**Total Quality Management**
PIOE426	**Project Management**	**PIOE429**	**Logistics & Supply Chain Management**

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
Credits	**20**	**20**	**22**	**23**	**21**	**24**	**21**	**15**

Total credits = 166

Semester/Course type	I	II	III	IV	V	VI	VII	VIII	Total	% weightage
IC	18	14	4	-	2	-	2	3	43	25.90
PC	-	4	18	23	10	11	10	3	79	47.59
PE	-	-	-	-	6	6	6	6	24	14.46
OE	-	-	-	-	3	3	3	3	12	7.23
NC	2	2	-	-	-	4	-	-	8	4.82
Total	20	20	22	23	21	24	21	15	166	100.00